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Abstract

The focus of this thesis is on generative processes applied in the context of art and design. Specifically, it looks at the conception and application of a suitable analogue generative system utilised for working with archival material from the Aalto Visual Resources Centre. The project is documented in detail to describe the process from conception through execution in a systematic and transparent way. The review of three different taxonomies and the analysis of selected works, as well as the identification of artists' motivations for using generative systems, are used to define the scope of generative art as well as to define and discuss the thesis project.

Keywords Generative Art, Generative Graphic Design, Analogue Generative System

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the Aalto Rare Books Collection

THESIS

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RESEARCH / PROJECT

Activating the Archive through Generative Systems —Remaking Images from the Aalto Rare Books Collection. Mixed media Prints, 42 × 59 cm. Siri Bachmann, 2017. Photos: Tove Ørsted.


Documents de Ferronnerie
Ancienne — PL. 22
L'Ornement
Polychrome — PL. XXII
La Plante et ses Applications
Ornementales — PL. 22


Palekh — 15
Decorative

Eesti Rahvariicia
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Ausgefuehrte Moebel und
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Mönster för Konstindustri
och Slöjd — I
Das Thier in der decorativen
Kunst — NO. I
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Holzarbeiter — TAFEL XXX
Enkin Chou
— DAI SAN JU GO
Plastische Ornamente
der Italienischen
Renaissance — TAFEL 30

1. INTRODUCTION

THIS THESIS PROJECT is the result of a residency program offered by Aalto University's new Visual Resources Centre (VRC), where a student, researcher, artist or designer works with the Aalto archive visual collections to produce a project and an exhibition. The program aims to raise awareness and support the use of the centre's resources.

The project required the use of a varied and representative sample of archival material and a strong visual concept for producing inspirational new images to showcase the centre's resources. The challenge of working with a large archive of materials like the VRC was to not get lost in the overwhelming amount of choices available. Having to select images for an art or design project from an extensive database can be daunting, especially if the selection cannot be narrowed down using specific interests or styles, but instead has to include a wide range of different contents.

A generative system, which employs an automated process at its core, can be an effective tool for reducing options and making controlled decisions throughout a project. This kind of systematic approach that focuses on automated or partially automated processes, significantly reduces or even eliminates the need for the constant moment-to-moment decision making that usually steers an artistic workflow.

The aim of this thesis is to examine how generative systems can be applied in practice within the context of art and design. The motivation arises from a wish to build a generative system that is appropriate for working with a large archive of materials. This system is used for the VRC project and can also serve as a tool for other designers working with similar projects, or act as an inspiration for building their own system.

To create this generative system, it is beneficial to study the ways generative systems can be applied to making art and design and learn what the advantages and drawbacks are of using such methods. For these reasons I am interested in the following research questions: How can I apply an analogue generative art system to the remixing of visual archive collections as a way to generate compelling images? What are the advantages and implications of a regulated, process-based technique both for the artist and the artwork?

Unlike what may be commonly assumed, generative art and design is not exclusively made with computer programming and digital algorithms but can also be made with analogue or mechanical means. In an analogue or mechanical system, the automated portion of the process is not controlled by a computer code. This however does not exclude the use of the computer as a work tool for other parts of the project. For this thesis project, the generative system is a set of written rules, an "analogue algorithm", carried out through the combination of digital and analogue work steps. The decision to work with an analogue system is based on several factors. First of all, compared to computational generative art, analogue generative art techniques allow for a creative, hands-on, human scale approach to the material, while still benefiting from the regulated, process-based nature of a generative system. This affords complete control and a thorough understanding of the process and its subsequent documentation. Furthermore, as the source material itself is analogue, working with analogue techniques takes into account and complements the nature of the selected source material.

Although the main interest of the research and project lies in analogue generative systems, the literature about generative art and design almost exclusively discusses computational systems. Several authors acknowledge generative art methods outside of the digital realm (Dorin et al., 2012; McCormack et al., 2014; Monro, 2009), but Philip Galanter is one of the few who discusses them more in depth and puts them into a larger context of art making that includes a vast variety of technologies. The premise of the research is based on his definition of generative art (elaborated in chapter 2.1). The analysis of Gerstner's theories from the 1960s shows that the use of generative methods is deeply rooted in the graphic design profession and puts the contemporary discourse around the use of self-made generative tools into a larger context.

The scope of the thesis does not include concepts relating to the remixing of cultural heritage or the larger discourse of remediation. Even though the project uses archival material within the context of a new project with the aim of bringing attention to its qualities for contemporary application, the scope is focused solely on the generative system aspect of the project. Neither does the thesis touch on questions relating to the philosophical issues implied in the use of automated processes for making art, especially when the computer is involved. To fully explore the problems concerning creativity and authorial responsibility when the control of an artistic process is given to a machine would be beyond the scope of this thesis.

The thesis is divided into two main parts: the project documentation and the research. The documentation portion of the text is a chronological account of the project from conception through production and is divided into four main chapters: the conception (chapter B), the system (chapter C), the execution (chapter D), and the production and exhibition of the project's outputs (chapter E).

The research portion of the text is divided into four main chapters. Chapter 2 aims to clarify and define what generative art is and where my project is positioned within the scope of it. Chapter 3 introduces a selection of artworks to illustrate different iterations of visual generative art. Chapter 4 looks at generative methods used in the field of graphic design.

Chapter 5 looks at artists' and designer's motivations for using generative processes, what the strengths and weaknesses might be, including the personal experiences and observations gathered throughout the project.

The project diary and the theory are not separate entities presented consecutively, but are instead threaded together into one text, continuously informing one another. The design of the booklet however, allows the reader to concentrate on each part separately as well, if this is preferred. The table of contents offers an overview of how the two parts can be viewed individually.

A. PROJECT CONTEXT

LAST AUTUMN I got interested in finding out more about the Aalto University Archives after seeing a selection of its contents in an exhibition organised by the University's Media Department. I contacted Marika Sarvilahti, the information specialist working at the Visual Resources Centre (VRC), in the Harald Herlin Learning Centre, who invited me for a meeting to discuss the possibility of doing my thesis project with the archives. She told me about the VRC residency program, where an Aalto University student, researcher, artist or designer works for a period of time with the Aalto archive visual collections to produce a project and an exhibition. We both agreed that the residency would be the ideal context for developing my project.

The next step was to get acquainted with the collections and find out with which materials I wanted to work. To this end, Marika introduced me to the contents of the physical archives as well as the visual resources available online. During this process Marika explained that very few students know and take advantage of these resources and expressed her wish to raise awareness about the VRC.

This is when I found out about the Rare Books Collection. It was the last piece of the archive that Marika showed me, and it might as well have been the only one. I completely fell in love with it and decided I would limit the selection of materials for my project to the book collection. Of course, as a book designer who loves old books and analogue printing techniques, my opinion is far from objective, but it is a hard to believe that anyone would not find these books beautiful.

Around this time, I participated in a workshop given by Sonnenzimmer, a graphic design and artist duo from Chicago that works a lot with screen printing and is interested in developing and using methods for making original imagery through generative processes. The process they proposed for producing images during the workshop was new to me and relied on a generative system that was mostly analogue. Sonnenzimmer had prepared a set of rules/working steps for us to follow that allowed room for personal interpretation. These steps regulated the process without being constraining and allowed for a carefree and spontaneous workflow that did not require continuous decision making. In addition to enjoying the work process, I particularly appreciated the result being achieved with the combination

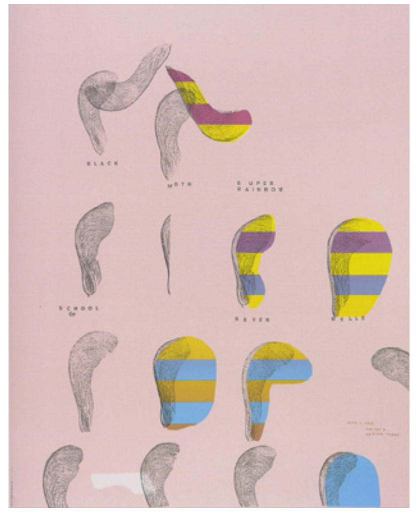


Fig. 1 *Black Moth Super Rainbow*. 4-colour screen print. Sonnenzimmer, 2009.
1. Go outside and collect a group of natural objects.
2. Scatter them with no intent on a photocopier.
3. make a copy.
4. Using a pencil, balance the arrangement by drawing a grid of lines over the copy.
5. Add colour to create three focal points following the grid.
6. Erase the grid.
7. Evaluate the composition.

BUTCHER&NAKANISHI, 2015: 15, 49

Fig. 2 *Efterklang Slaraffenland*. 6-colour screen print. Sonnenzimmer, 2008.
1. Cut out three shapes from a letter-sized sheet of blank paper, keeping the paper intact.
2. Find a magazine spread.
3. Place the cut paper over the magazine as a mask.
4. Create an energetic abstract drawing on the cut paper, incorporating the revealed magazine image.
5. Remove the cut paper from the magazine.
6. Cut out two 2"× 2" photographic images from a different source.
7. Glue those images to the abstract drawing.
8. Photocopy result.

BUTCHER&NAKANISHI, 2015: 28, 62

of both analogue and digital work steps and the fact that there was both an analogue and a digital end-result. Fig.1 and Fig.2 are posters and composition exercises from Sonnenzimmer's book *Didactics* (2015).

During the spring semester I took the course "Generative and Interactive Narratives", where I got better acquainted with and excited about generative systems. Even though the course mainly revolved around storytelling and computer programming systems, I focused more on design and visual art projects that employed analogue generative systems. I soon thought that a generative system could be an interesting approach for working with the archival material. It was during this course that I first got in contact with the theory of generative systems which clarified rules and boundaries for defining my own project.

During the autumn and the spring semesters, I also took a silkscreen course. The course made me realise how much I had missed working with my hands and having to take time to produce work due to the inherent constraints of the technique. Inspired by Sonnenzimmer's workshop and the desire to work with analogue techniques, the idea of employing silkscreen printing for my thesis project was not far off.

The knowledge, ideas and inspiration I gathered through the encounter with Marika and the courses I was taking during that time all weaved together and shaped my thesis concept quite organically over the course of six months. By the time the spring semester was over I was ready to actually start working on the project.

2. WHAT IS GENERATIVE ART?

BEFORE I STARTED the research for this thesis I had a vague idea of what generative art entails. I thought it referred to complex digital geometric or organically flowing abstract works I saw popping up "everywhere" online. The largest misconception people commonly have about generative art is that it is computer generated, with a program that is based on certain coding specifications and produces one or more images. (Galanter, 2006 : 1) However, this is a quite narrow definition that only includes a section of generative art.

There are many definitions, opinions and variations of the term generative art that create confusion about its actual meaning. Some of these terms include: rule-based art, systemic art, process-based art, digital art, computer art and electronic art. Fortunately, some authors and artists have tried to clarify the muddled pond that is generative art by defining clear conceptual boundaries and by exemplifying their theories through the analysis of selected artworks. In this chapter I will first clarify what characterises generative systems and in what instances they differ from rule-based ones. Then, I will look at three different frameworks with which generative systems can be classified, analysed and ultimately understood. This chapter aims to not only clarify what generative art is but also to show where my own project is placed within the scope of it.

2.1. DEFINING GENERATIVE ART

Philip Galanter, artist, professor and curator from Chicago, uses generative methods in his works and has written about generative art on various occasions. His widely accepted definition of generative art (Dorin et al., 2012; McCormack et al., 2014; Monro, 2009) is also the most inclusive one:

> Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art (Galanter, 2003 : 4).

Galanter lists three important points to notice here. First, generative art refers to a method rather than a style. This indicates that it is not an art movement following a certain philosophy or belonging to a specific period in art history. Second, it becomes immediately clear that generative art can be made by systems other than computer programs. This opens up the definition to include any sort of analogue procedures as well.

Third, the system has to have an autonomous part of the process that, once initiated, is out of the artist's control. This excludes all art made in traditional ways, where the artist makes decisions from one moment to the next throughout the artistic process. (Galanter, 2003 : 4; Galanter 2006 : 1)

The partial loss of control of the artist is a key aspect of generative art. The controlling system can vary greatly in nature. Computer programming is an effective way to cede control to an autonomous system, but the use of mechanical movements or a set of written rules can equally serve the purpose. Less obvious autonomous processes can include chemical reactions such as condensation, melting or crystallisation, or biological processes like growth or decomposition (Galanter, 2006 : 1).

The possibility of multiple outcomes is another important characteristic of generative art. Galanter does not specify it in his definition but mentions it separately: "The word 'generative' … directs attention to a subset of art, a subset where potentially multiple results can be produced by using some kind of generating system" (Galanter, 2003 : 4).

It is important to know that applying rules to an artistic process does not make it automatically generative. And vice-versa, not all generative systems are rule-based. Galanter clarifies the distinction between generative art and rule-based art and points out that while the two art forms are not the same, they overlap in some areas. The balance between having a set of rules that is too open or simple (resulting in possibly anything), or too restrictive or detailed (resulting in a predictable exact result, without the space for variations) is what helps defining whether an artwork is generative or rule-based. The main distinction can be made by identifying the presence of an autonomous component: "Generally rule systems which are not generative lack the specificity and autonomy to create results 'on their own'" (Galanter, 2006 : 9). If a set of rules is not specific enough to be carried out without making step by step decisions, it is not generative. Distinguishing between different kinds of rule-based art can help illustrate which ones are generative and which ones are not. "Constraint rules", for example, are not generative. They merely limit the artwork's execution to specific constraints. These might be a choice of material, colour or technique, a limitation of size or time. The artist however, will still move freely within these set borders making decisions and improvising as he pleases. Other examples that are not generative include what Galanter calls "inspirational rules", such as following the intentions and motives of an art manifesto, because they are too open, and "rules as plans for installation or fabrication", such as blueprints or instruction manuals, because they are too restrictive, and their result is already predetermined (Galanter, 2006 : 9–11). "Rules as algorithms" and "numerical sequences as rules", on the other hand, are generative. Both rely on external mathematical systems for the autonomous process. Other generative rule-based examples include "tiling and other symmetric composition rules" that rely on a visual composition system that creates a certain pattern, and "chance operation rules" that use chance to automate their process, such as rolling a dice or picking a number from a hat. Finally, also considered generative are: "rules as recipes for autonomous processes", where the rules could be executed by someone else than the artist, such as rules for a game, and "clustering rules that create composition", where a certain categorisation is applied to a group of objects to create controlled combinations, such as the grouping of wooden objects together (Galanter, 2006:12–14).

The last two examples, the "rules as recipes" and the "clustering rules", are particularly interesting in relation to my project. "Rules as recipes" is the type of system I used: a generative process based on written rules that clearly describe the procedure and could therefore be carried out by someone else (Link). This was made with the wish in mind, to put forward a tool for other designers to apply to their own choice of material. "Clustering rules" relates to my project for two reasons. One, I worked with the clustering and categorisation of visual archival material by creating tags and rules that generate controlled combinations. Two, it introduces the possibility of applying generative processes to existing objects or materials. This was an important confirmation in the early stages of my project, since almost all projects dealing with visual generative systems I had encountered up to that point, were generating original visual material from abstract concepts and not using existing visuals as a point of departure.

Fig. 3 *Neue Einfache Pflanzenornamente*, Plate 3.

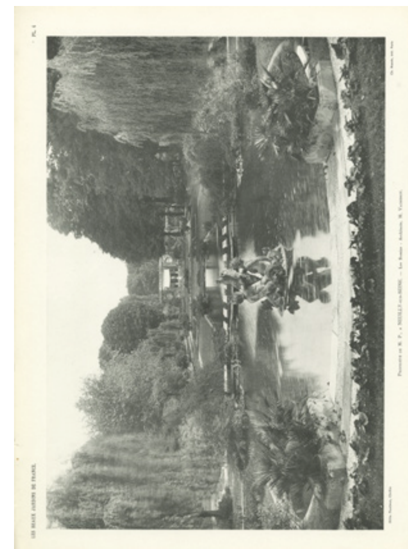


Fig. 4 *Les Beaux Jardins de France*, Plate 4.

Fig. 5 *Die Praxis des Firmenschreibers*, Plate 22.

B. PROJECT CONCEPTION

May–June

B.1. SOURCE MATERIAL: THE RARE BOOKS COLLECTION

I decided to limit the material I used in my project to the Rare Books Collection of the VRC. The collection consists of ca. 300 books from the 1880–1930s that were used as teaching material to show examples and inspire the students for their own works. They are full of beautiful images ranging from architectural photography to sculptures and furniture, from textile and ceramic patterns to animal and plant drawings for decorations (Fig.3–11). The vast majority of the books are made in Germany, France and Austria. Other countries of origin include Finland, Russia, Estonia, Sweden and Japan.

My main motivation was the beauty of the material, I felt it could still be valuable as a source for inspiration in contemporary projects. But there are other factors that influenced and supported the choice.

For one, I thought it would be beneficial to choose a pool of images that are visually related. The Rare Books Collection is a large sample of material, with varying contents but with common attributes: all books are from the same time period, have similar material properties and are all within the scope of the visual arts. This allows for visual coherency throughout the project. The fact that all the books are stored in the same place, which offers practical advantages for the selection, handling and digitisation process, as well as the fact that almost all the books are in familiar languages, were added bonuses to me.

Another factor was the obscurity of the material. The books are not yet digitised nor directly accessible to the public, which makes them currently virtually unfindable. By using them for the project I could make them less obscure and hopefully reactivate their original purpose of being a source of inspiration to other students, while also addressing the more general visibility problem of the VRC and all of its resources.

Right after the beauty of the images themselves, the books' most striking attribute is their strong materiality: The high-quality printing craftsmanship, the beautiful colours, the papers and the large sizes. In order to reflect these properties, I decided that the final product should at least partially be produced with a high-quality analogue printing technique. Silkscreen printing meets these criteria, which turned my vague wish of working with silkscreen in my project into a meaningful and conceptually sound motivation.

The size of the original material was also something I wanted to be visible in the final prints. Showing reproductions in their actual size or at least making a clear decision about their scale is something I always consider when working in print. Maybe it just comes from years of working with architects and their carefully scaled floor plans, but I do think it is an important information that too often gets lost or grossly distorted in the digital world. In this case it was also a welcome restriction that could be used as a rule for the system. I was able to follow through with staying true to size and ended up using only two scales for all the images in my compositions, either 100% or 300% of their original size.

B.2. DIGITISATION OF THE MATERIAL

The next step of the project was the digitisation of the material. Since the Rare Books Collection contains around 300 books, I still wanted to narrow down my choice to only include a selection of them. I knew that I wanted to employ a generative system already for this stage, as it would strongly influence the overall outcome of the project. The only clear rule I had for selecting the books from the collection was that they would have to fit on the A3 scanner I had available for digitising them. This decision was not only a practical one but was also based on my previously mentioned wish to work with the original sizes of the material. The A3 size would be easy to maintain and work with throughout the entire project, including the production of the final silkscreen prints. Other than adhering to the size restriction, I simply tried to choose a wide range of different contents to avoid too much visual repetition and simultaneously reflect as truthfully as possible the contents of the whole collection. I selected 40 books of which 30 ended up in the project.

Once the books were selected, I had to pick which pages to scan. For the choice of pages I wanted to have a clear system that would not allow for personal preferences or oth-


Fig. 6 *Das Thier in der Decorativen Kunst*, Plate 4.

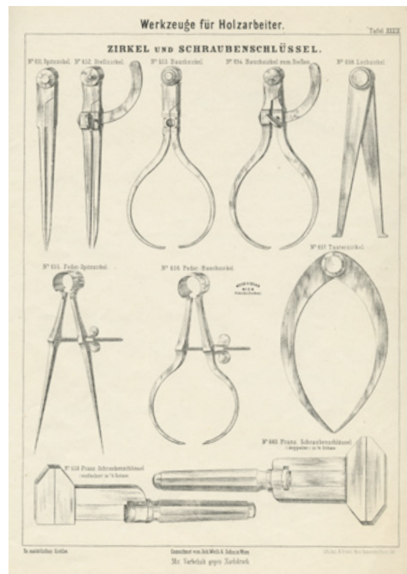


Fig. 7 *Atlas Österreichischer Werkzeuge für Holzarbeiter*, Plate 39.


Fig. 8 *Moderne Wiener Plastik*, Plate 3.

B. Project Conception


Fig. 9 from *Rahmen*, Plate 9.


Fig. 10 *La Plante et ses Applications Ornementales*, Plate 4.


Fig. 11 *Alt Orientalische Teppichmuster*, Plate 1.

er influencing factors to interfere. Firstly, since I did not have the whole process of the project laid out in detail at that point, I wanted to make sure I had a broad enough selection of pages from each book to make sure I would not have to go back and make more scans at a later stage. Secondly, I did not want the page selection to be decided by chance, even though this is a valid and widely employed generative system. This was because I thought that choosing the same group of pages from each book might be interesting at a later stage, where the same page number of different books could become a rule for combination. Thirdly, I wanted the page selection to be distributed throughout the volume and not concentrated for example in the beginning of the book. This would allow for a more accurate representation of the book, since different chapters can contain quite different material. After observing that the average length of the books was somewhere around 30–40 pages, I decided on the following sequence of ten page numbers: 1, 3, 4, 6, 9, 10, 15, 22, 30, 39.

I did not have to worry about the fact that some pages might not contain any images. Books from this period, that consist mainly of large image plates, usually have a few introductory pages of text in the beginning, often with a compiled list of image captions, and all the image plates after, with separate numbering. This was done for several reasons, one of them being the different printing techniques of letterpress for the text and lithography for colour images.

The fact that ultimately not all pages of the sequence were available in every book depended on other two things: either the book was shorter than 39 pages, or the page was missing altogether. Pages can easily be missing from old books like these, since most of them were not bound together in a volume but consisted instead of a stack of single prints collected in a portfolio.

By following the rules I had set for myself, the scanning process ended up being automatic and swift work, because I did not have to continuously stop and decide whether I should pick a page or not. I was careful to name every scan right away with its correct page number and kept track of which pages were missing from each book with the help of a simple table. I also scanned the title page of each book to make sure I had the title and other information right next to the content whenever I needed it. The ca. 400 scans I made were also passed to the VRC for their online database.

B.3. TRY-OUT PHASE

B.3.1. INITIAL TESTING

Once I had made all the scans, I could start working with the material. At this stage I did not yet have any clear idea of what I would do with the images, except a notion of wanting to combine them based on certain criteria still to be defined, and layer them into compositions. I had experimented with a small batch of test scans in the silkscreen course by choosing two pages with the same page number from different books, converting them into halftone images and printing them in two overlapping layers with two different colours (Fig.12). I left the pages in their actual sizes and picked the colours for printing from the original images. These first experiments were made to test the effect of the printing technique and colour combinations as well as get a first feel for the material. The pairing was still mostly done through personal choice, and the composition was the simplest possible.

Later in the spring I expanded the testing during a one-week mixed-media workshop, which allowed me to experiment with inkjet printing on different materials. I tried out if the layering effect might be achieved by stacking images printed on very thin or transparent papers and foils (Fig.13). While this particular idea did not produce any results I wished to pursue further, the workshop helped me realise that I wanted to keep some of the images in their beautiful original full-colour. I could achieve this without discarding silkscreen printing completely but by mixing the two printing techniques together instead. I tested it by printing an image with inkjet on silkscreen paper and then printing with silkscreen on top of it (Fig.14). The mixed printing worked well and ended up being the technique I used for the final outcome of the project.

To get started with faster and more extensive testing than what I had done during the silkscreen and mixed-media courses, I decided to make quick digital print-outs of the scans that would help me get an overview of the material and that I could later work on manually. To achieve this, I first placed and centred all my scans in A3-sized inDesign files, in their original sizes (100%). In this way the size ratio

Fig.12 Silkscreen test.

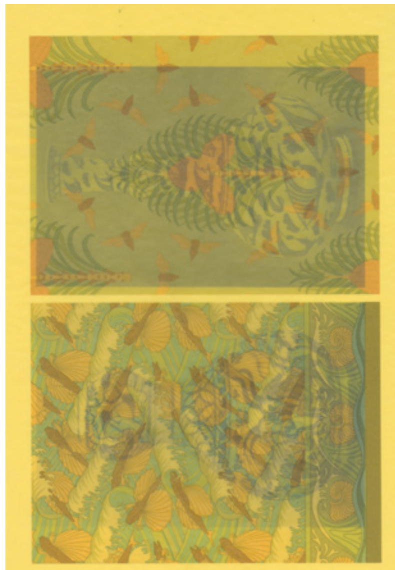


Fig.13 Inkjet test on foils.

Fig.14 Inkjet and silkscreen test.

Fig.15 Pages 1, group overview.

Fig.16 Example of a pattern image.
Tag: B–LI–PA–P–C.

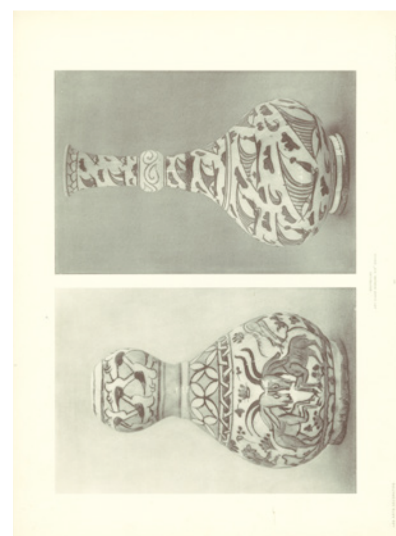


Fig.17 Example of an object image.
Tag: S–DE–OB–L–BW.

between all the books would stay constant and true to reality even if I printed them out in smaller scales. Then, I printed them all out on A4 paper and grouped them, based on their page numbers, into 10 groups each containing up to 30 pages. I laid out each group on the floor in rows of 7 and photographed them. To try and bring a system into this stage that could help me see and compare the groups better, I ordered the pages within the groups by size and colour: first the colour images from the largest to the smallest, then the black and white images again from big to small. At the end of this process I had a complete overview of the material ordered into 10 pictures (Fig.15).

B.3.2. TAGGING AND PAIRING TESTS

Once I had my 10 groups ordered and ready I focused on the group of pages 1 to develop and define the rules for my system. First, I defined additional criteria for pairing the images. Colour and size being the first two. The third criterion I defined was the density of the images, which had already become relevant during the silkscreen tests. When overlapping two highly dense images, the result is going to be less clear and readable than if at least one of the two images has a lighter density. The fourth criterion refers to the content of the image rather than its form. Roughly half of the images depict decorations or patterns whereas the rest depict objects or places. The pattern images are two-dimensional and have mostly abstract and repetitive qualities, while the object images are more three-dimensional and contain one or more concrete objects (Fig.16–17). Combining these two kinds of images could generate more interesting results than the combination of two pattern images. The fifth and last criterion I defined was simply the orientation of the picture, i.e. portrait or landscape.

Next, I proceeded with tagging every image in group 1 with the 5 attributes I had decided on: *small* or *big* (S/B), *light* or *dense* (LI/DE), *object* or *pattern* (OB/PA), and *portrait* or *landscape* (P/L), *colour* or *black&white* (C/BW) (Fig.16–17). Since it is an either/or system that does not allow for in-between areas, some of the attributes were less clear to appoint than others. While appointing the tags for colour and orientation did not require any further thought, deciding if a photograph of a tapestry is an object or a pattern, especially if the pattern on the tapestry shows objects, is not as obvious. In these unclear cases I had to make judgment calls. Throughout the project I changed the tags of some unclear cases, for example from *pattern* to *object* and vice versa, if I noticed that the pairings seldom turned out to be advantageous.

Once my first group was tagged I proceeded with the combinations. In my first pairing test I combined images with identical tags with images that have the exact opposite tags, except for the orientation, which had to be the same (portrait with portrait, landscape with landscape). For example, images with B–C–LI–OB–P would get paired with S–BW–DE–PA–P. However, I soon noticed that a lot of the images in the group ended up not having perfect counterparts, because there were too many criteria that had to be met in order to make a pairing. I decided to deactivate the least relevant tag (*colour/black&white*) to achieve more pairing possibilities.

B.3.3. TESTING COMPOSITIONS

Now that my pairings for group 1 were made, I was ready to start testing compositions. I had the A4 print-outs ready to work on manually with scissors and a photocopier. Sonnenzimmer's book *Didactics* (2015) provided a lot on inspiration for this phase, especially in regards to working with the photocopier and the masking of images (See Fig.1–2).

Knowing that I wanted to produce the final prints with silkscreen printing influenced the compositions from the beginning. Specifically, I kept two characteristics of the printing technique in mind. The first one is that it only allows to print one colour at a time, which means that an image with three colours has to be printed in three layers. The second one is that in order to reproduce a photograph, or any image containing different tonalities, with silkscreen, it has to be converted into a bitmap first.

The layering of images in my compositions is a result of keeping the silkscreen technique in mind, as is the choice of working with one-coloured bitmap images and solid shapes for some of the layers. Working with a photocopier during the initial phase turned out to be the perfect analogue tool for quickly testing the effects of layering and

Fig. 18–19 Photocopy tests.

Fig. 20 Photocopy test with geometric mask.

Fig. 21–23 Examples of organically shaped masks put on top of images.

one-coloured images. The layering can easily be achieved by making several copies on the same piece of paper, and the one-colour option of the photocopier quickly converts full-colour images into one of the basic CMYK colours.

The first composition I did with the photocopier was the overlapping of 2 whole pages on top of one-another, like I had done in the silkscreen tests (Fig.18–19). Except that now I had clear pairing rules and the possibility of quicker and thus more extensive testing. The first compositions with the use of scissors consisted in cutting out parts of one image to combine with parts of another, the simplest example being the combination of the top half of an image with the bottom half of another. Then I moved on to using masks made of white paper to cover parts of images. This allowed me to test different things on the same print-out, without cutting it to pieces every time. The first masks were basic geometric shapes, like squares and circles. I would cut out a circle in the centre of a white piece of A4 paper, cover an image with it, make a photocopy, put the photocopy back into the paper tray and proceed to copy another masked image on top of the first one. To achieve zooms, I would simply make the circle in the mask smaller and then use the enlargement option when making the copy (Fig.20).

Soon I was cutting the masks into less geometric and instead more freely-drawn, organic shapes, and felt the need to have a system for making them, in order to stay true to the generative process. I decided on solving this with the use of a simple grid. I would fold a white piece of paper into a grid of 2 by 4 and draw the shapes into the confines of the grid spaces. The shapes would always have to touch the 4 sides of the space they were occupying (Example). When cutting out a mask, I would keep both parts of the cut-out and use the inner part for copying white spaces into the first image and then copy the second masked image on top of the white space (Fig.21–28).

B.3.4. TRY-OUT PHASE: FINDINGS

The try-out phase not only helped me to find the visual language and compositions I wanted to work with, but also further clarified the rules for my system. One important realisation I made was that the relevant tags and tag-pairings of the images would change depending on different types of compositions. For example, If I masked and zoomed an image, its original orientation would not be important anymore. In certain compositions the original colour of the image would have no significant impact on the final image, in others the density of the paired images had to be the same rather than the opposite, and so on. Based on these observations I decided to define three different categories of compositions: *overlappings*, *mosaics* and *shapes*. *Overlappings* are compositions made with the layering of two whole images on top of each other, like in the silkscreen tests *Mosaics* are compositions made with parts of two images combined with each other to make a new image. *Shapes* are compositions made with the layering of two masked images. The three compositions types each required different tag settings. For *overlappings* the relevant tags are size, density and orientation. For *mosaics* the relevant tags are colour, density and content (object or pattern). For *shapes* the relevant tags are size, density and content. This meant that while I would still tag the pictures with 5 attributes, only 3 relevant tags would be “active” depending on the composition. It also meant that an active tag could be paired with itself as well as its opposite. For example, while *overlappings* require the density tag to pair with its opposite (DE with LI and vice versa), mosaics require it to pair with the same (DE with DE, and LI with LI). Each image is therefore paired in three different ways for each type of composition. The tagging rules and different types of composition are explained in detail in chapter C: The system (Link).

Another decision that formed during the try-out phase concerned the final product. I decided that out of all the variations the system would generate, I would be able to produce 10 with silkscreen printing: 1 per group. This decision was based on the amount of work the printing would require. I also wanted all 30 books to be represented within these 10 final prints: 3 books per print. This meant that I had to come up with how I would get a third image into my

Fig. 24–26 Photocopy tests with organically shaped masks.

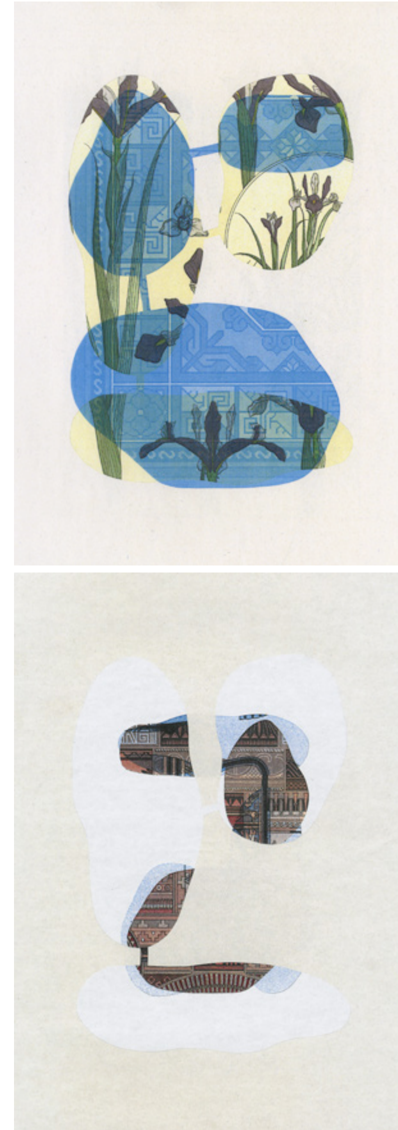


Fig. 27–28 Photocopy tests with organically shaped masks.

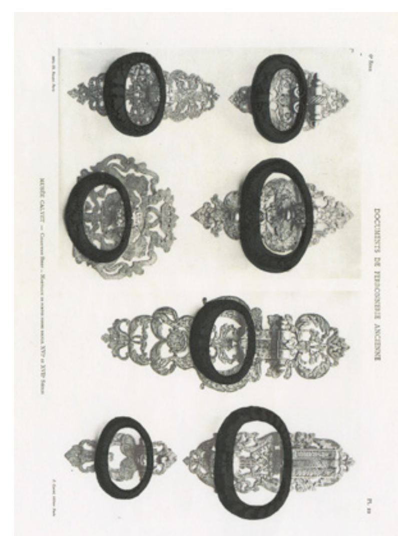


Fig. 29 Example of a traced image with black marker for making the third layer.

system of compositions, which was based on making pairs. I decided that the third image would always have to come from the same pairing group as the first two. For example, if images 3 and 5 have identical active tags and are paired with their counterparts 11, 17 and 22, these five pages are in the same pairing group.

Since I had been committed to changing the original material very little so far, with the intent of keeping it recognisable, I decided on doing something different with the third image/layer. Keeping the silkscreen in mind I was soon looking for a system that would produce simplified graphical patterns out of the third images. With a thick permanent marker I drew directly on the print-outs, tracing selected shapes from the images (Fig.29). The ink would push through the paper making only the drawing visible on the back of the print-out. This allowed me to copy them directly onto my compositions.

Finally, after seeing that the system produced several hundred compositions with only one group, I realised that 30 books with up to 10 scans of each was too much material. However, instead of simply eliminating a part of the material at this stage, which felt very difficult to do, I decided to make an extra rule for the process. The rule dictated that after applying the system to each group of images, I had to choose which pages I would use for the final print before moving on to the next group. The books containing the selected pages would then not be available anymore for the rest of the groups. Since I used 3 pages/3 books for each of the 10 groups/10 prints, this rule allowed me to make use of each of the 30 books as I wished, but only once. Since the choice of pages would always be made after each group had generated its outputs through the system, it could be based on personal preference.

To keep the amount of work within reasonable boundaries, I decided to make and add the third layer only after choosing the images for the final print at the end of every group. If I go back to the example from earlier, after making all possible variations within the pairing group (3 and 11, 3 and 17, 3 and 22, 5 and 11, 5 and 17, 5 and 22), if I choose images 3 and 17 for the final print, the third image has to be either 5, 11 or 22. By doing it in this order, I only have to draw a single third-layer pattern per group, instead of up to 30.

2.2. FRAMEWORKS FOR THE ANALYSIS OF GENERATIVE ART

To provide a better understanding of what generative art entails, this chapter looks at three frameworks that classify and analyse it. The first framework gives a wide-angle perspective of generative art and aims to position it within the scope of different types of electronic and non-electronic art by focusing on their technologies. The second framework takes a closer look at the systems involved in generative art by proposing a categorisation based on their levels of order and complexity. The third and most detailed framework puts forward a way of analysing generative systems by dissecting them into four main components. All three frameworks offer different perspectives on generative art, that combined create a more complete picture of its definition.

2.2.1. GENERATIVE ART TAXONOMY

The first framework for differentiating between generative artworks is put forward by Margaret Boden and Ernest Edmonds in their research paper "What is Generative Art?" (2009). Boden & Edmonds' taxonomy offers a wide-angle perspective on generative art, that includes sub-categories defined by their respective technologies. The taxonomy helps to clarify terms used, often interchangeably and inaccurately, to describe different kinds of art forms involving the use of the computer, such as: generative art, computer art, digital art, computational art, process-based art, electronic art, software art and technological art. They especially wish to define generative art in relation to the other art forms, since it differs from all other kinds of art in that it is produced through a system that at least partially takes over the decision-making of the artist. Their definition further agrees with Galanter's in that it also acknowledges that not all generative art involves computers. (Boden & Edmonds, 2009: 3–4)

Their taxonomy discerns eleven types of art, each clearly defined and characterised. However, as one can expect, these categories are not decidedly marked-off and isolated from the others, which causes a lot of overlappings and sub-categories. To help keep a clear overview of the categories and their intricate relationships, I made a schematic visual representation of the taxonomy. The resulting Venn-diagram (Fig. 30) helps position generative art and consequently also my project inside the taxonomy. You will notice that I position my project in the Non Ele-Art side of G-Art, even though it is computer-aided in the sense that I used the computer as a non-essential tool in the process. This is because the system at the core of the generative process is analogue and did at no point get controlled by the computer. In fact, you will find that the whole artistic process could theoretically have been done without the use of the computer (Detailed system in chapter D).

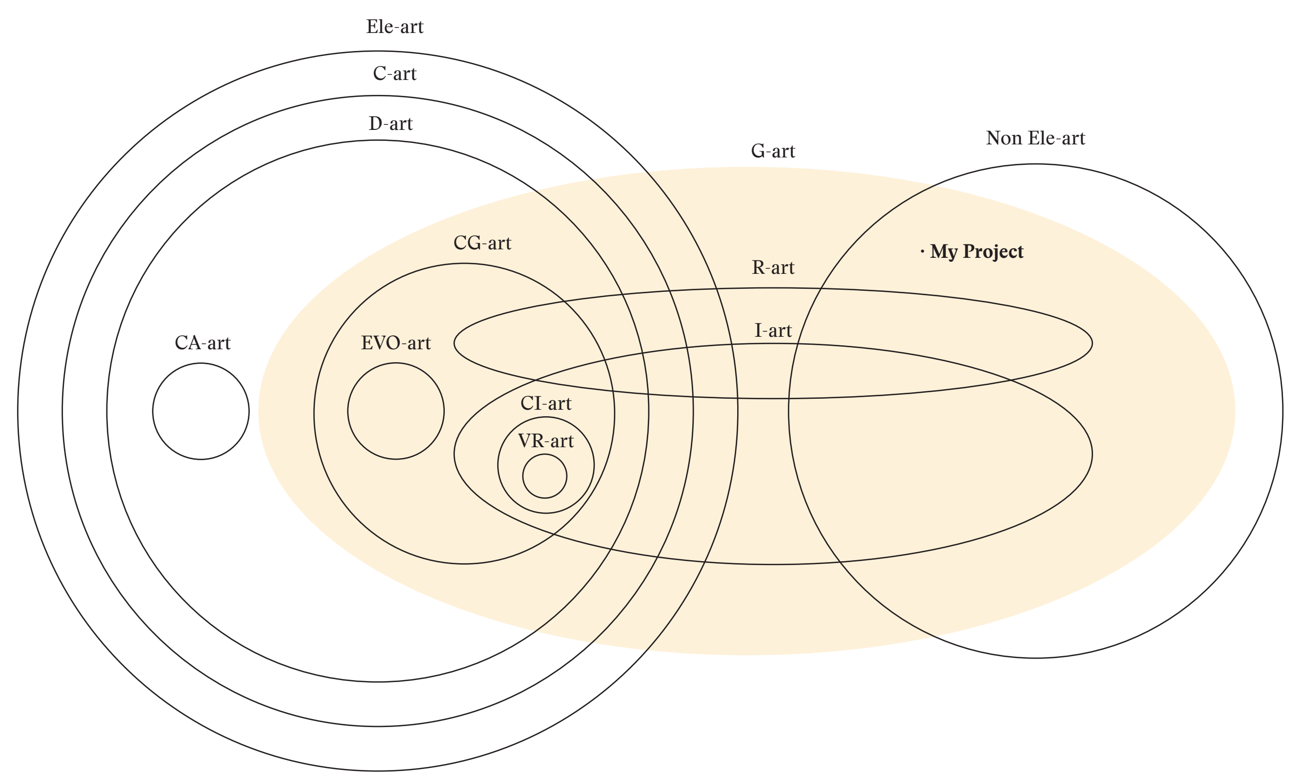


Fig. 30 Visualisation of Boden & Edmonds' *Generative Art Taxonomy*

· **Ele-art** (electronic art) involves electrical engineering and/or electronic technology.
· **C-art** (computer art) uses computers as part of the art-making process.
· **D-art** (digital art), uses digital electronic technology of some sort.
· **CA-art** (computer-aided) uses the computer as an aid in the art-making process.
· **G-art** (generative art) works are generated, at least in part, by some process that is not under the artist's direct control.
· **CG-art** (computer-generated art) is produced by leaving a computer program to run by itself, with minimal or zero interference from a human being.
· **Evo-art** (evolutionary art) is evolved by processes of random variation and selective reproduction that affect the art-generating program itself.
· **R-art** (robot art) is the construction of robots for artistic purposes, where robots are physical machines capable of autonomous movement and/or communication.
· In **I-art** (interactive art), the form/content of the artwork is significantly affected by the behaviour of the audience.
· In **CI-art** (computer-based interactive art), the form/content of some CG-artwork is significantly affected by the behaviour of the audience.
· In **VR-art** (virtual reality art), the observer is immersed in a computer-generated virtual world, experiencing it and responding to it as if it were real.
(Boden & Edmonds, 2009: 19)

2.2.2. ORDER, DISORDER AND COMPLEXITY

While Boden&Edmonds' taxonomy provides a better understanding of what generative art encompasses, it is useful to take a closer look at its sub-categories to further understand, discuss and compare different types of generative art. Galanter (2003) proposes a way of categorising the different systems laying at the core of generative art processes, by looking at their relative levels of order and complexity.

A system is considered complex if it consists of many smaller parts that interact with neighbouring parts, leading to bigger scale changes in the system without the influence of a controlling external agents. In other words, the system yields something more than what could be accounted for by the sum of its parts. This phenomenon called "emergence" is one of the main motivations for using complex systems in generative art, which I will discuss further in chapter 5. If these self-organising systems are able to adapt to environmental changes without the loss of integrity, they are regarded as complex adaptive systems. Genetic algorithms, such as cellular automata and L-systems, which derive/borrow their processes from nature, are examples of this kind of systems. (Galanter, 2003 : 5; Rutanen, 2017 : 17–21) Simple systems, on the other hand, consist of a comparatively small amount of parts, which interact in a linear and predictable way. The output of a simple system can logically be traced back to its components and agents, and does therefore not exhibit any emergent, seemingly independent behaviour.

Galanter states that a system's level of complexity is directly correlated to its level of order and disorder, roughly following the shape of a bell curve. This correlation is illustrated with the help of a graph, where different types of systems are placed along the x-axis of complexity and the y-axis of order/disorder (Fig.31). Highly ordered generative art systems are for example those that rely on mathematical systems, like geometric order, seriality, and number sequences. On the other side of the spectrum, highly disordered systems are determined by randomisation, which rely on chance. Both pure randomness, caused by physical processes such as rolling dice or picking a number from a hat, and pseudo-randomness determined by computer algorithms are highly disordered systems. Surprisingly, both highly ordered and highly disordered systems are considered simple, while complex systems are a combination of order and disorder. Consequently, Galanter argues, neither a highly ordered system nor a highly disordered system will keep the attention of an audience and recognises that an interesting complexity lies somewhere in-between. He exemplifies this by stating that in music, both repeating a single note for a long time and playing a random combination of notes, are equally uninteresting. (Galanter, 2003 : 8, 15)

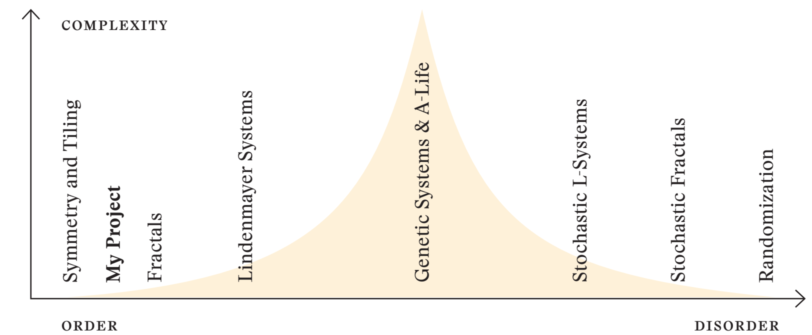


Fig. 31 Galanter's *Generative Art Systems* graph.
Adapted from GALANTER, 2003 : 12

Organising generative art systems on a scale of order/disorder and simplicity/complexity is a way of better understanding their outcomes. Considering these factors when working on a generative project can help motivating the appropriate choice of system to employ for a desired outcome.

I would categorise my project as an ordered system with a low level of complexity. I did not employ randomisation in any of the systems' steps, because I wanted it to be logically constructed based on conscious decisions about form and composition. However, introducing a small random action somewhere might have caused interesting variations and raised the level of the project's complexity without compromising its overall order and logic.

2.2.3. FOUR CHARACTERISTICS OF THE GENERATIVE ART SYSTEM

Like Galanter, Dorin et al. (2012) propose a framework built around the core of generative art: the system. They, however, go into further detail by identifying four components that together characterise a generative system: *entities*, *processes*, *environmental interaction* and *sensory outcomes*. The definition of these components for any given generative system facilitates the analysis and critique of widely differing artworks.

"*Entities* are the subjects upon which a generative artwork's processes act. They may be real or conceptual". They have properties like position, velocity and form. The relevant attributes are those which are affected by the process. (Dorin et al., 2012 : 244)

2. What is Generative Art?

"*Processes* are the mechanisms of change that occur within a generative system". They act on the system's entities and can be controlled by physical, mechanical, computational or human controlled systems. They are not always evident to the viewer. A process has "initial conditions" which describe the state of the entities before the beginning of the process, and "initialisation procedures" which describe the actions or conditions that cause the process to start. Processes always start but not necessarily have an end.

Environmental interaction "describes flows of information between the generative processes and their operating environment". It may be sporadic or continuous, influence initial conditions or have an effect during the execution of the process. It may be caused by users interacting in real-time or by the artist adjusting parameters based on assessments of the system's outputs.

Sensory outcomes are "the experienced aspects of a generative work", which can be images, sound, music, literature, sculpture, etc. They can be static or time-based, the final outcome of a process, documented in-between steps or a live process unfolding. They are often multiple, showing iterations of a process. (Dorin et al., 2012: 245–246)

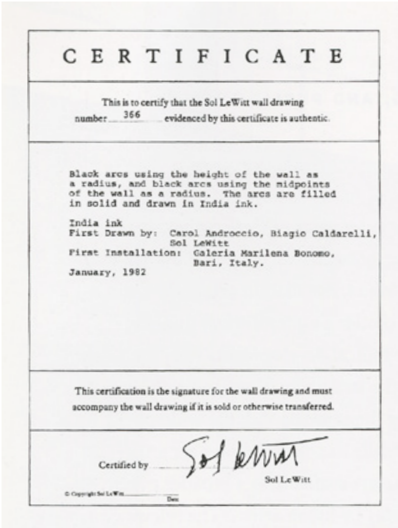
The authors introduce selected project examples to illustrate how the four components can differ between systems and compile them into a table (Fig.32). These short explanations of the projects in question enable a better understanding of the table. *Islamic star patterns* are tiling works based on geometric constructions. *Paragraph 7* is a piece from composer Cornelius Cardew's series *The Great Learning* and is a "self-organising choral work" based on written instructions. Each singer establishes relationships with his neighbours which cause self-organising patterns. *Process 18* is a work by Casey Reas made with computer coding. Reas defines the movements and compositions of lines across a plane, which add up to complex shapes. This work is described in more detail in chapter 3.3. *Tree Drawings* is a series of works by Tim Knowles, for which he employs the movement of tree branches in the wind to generate drawings. These works are described in more detail at the end of chapter 3.1. *Rule 30* by Kristoffer Myskja is an electromechanical machine that punches holes in a paper roll, based on the automaton rule 30. The generated pattern is the visual representation of the rule in two dimensions. (Dorin et al., 2012: 250–255) Cellular automata are explained in more detail in chapter 3.3.

By following the table and project examples. I offer a tentative analysis of my project based on Dorin et al.'s framework.

WORK DETAILS	ENTITIES	ITITIALISATION/ TERMINATION	PROCESSES	ENVIRONMENTAL INTERACTION	SENSORY OUTCOMES
Islamic star patterns (c. ninth century CE)	Points, lines, circles, rhombuses, used in the geometric construction	Termination determined by the boundaries of the workspace	Geometric constructions; the exact processes are unknown; possible rules to construct a pattern include: specify drawing of lines and placement of shapes, colouring regions, specification of which construction lines are removed after the pattern has been generated	None after completion	A static work on a building or manuscript page; flat system
Paragraph 7, Cardew (1971)	Human singers (sound-making agents)	Random initialsation: "Leader" may signal start and end of the work	Agent state changes through interaction with neighbours; finite set of singing tasks performed by each agent; agents move and listen to neighbours	Room acoustics	Self-organising choral work; flat system
Process 18, Reas (2008)	Lines with state (size, position, velocity)	A rectangular surface randomly filled with instances of lines of different sizes and grey values; no termination condition	Entity behaviours: move in a straight line; enter from the opposite edge after moving off the surface; orient toward the direction of the element that is touching; deviate from the current direction; draw a quadrilateral connecting endpoints of each pair of lines that are touching; increase the opacity of the quadrilateral while the lines are touching and decrease while they are not	None	Accretive image formed through temporal interaction; artist-defined mapping
Tree Drawings, Knowles (2005)	Tree, pen, ink, paper, easel	Fixed initialisation—pens attached to selected branches and placed on a blank canvas; process end determined by artist	Natural physical movement based on environmental conditions that cause the branches to move	Meteorological environment—wind and weather behaviour	Accretive image formed through temporal interactions; flat system
Rule 30, Myskja (2008)	Electromechanical machine: gears, motors, hole punches, etc.; paper roll	Deterministic initialisation of cell states—begins with one cell 'live'; process ends when machine runs out of paper or is stopped manually	Physical, hole-punching machine implementing CA Rule 30; 1-D local interaction between immediate neighbours (punched holes in the paper roll)	None	Pattern of holes in the paper roll; the machine performing; flat system
My Project, Bachmann (2017)	Archival images with state (5 formal attributes compiled into tags), masks, patterns (third layers)	Process initialisation determined by artist; termination when all compositions have been made	Combinational rules based on tags, placement; composition rules based on written instruction.	Sporadic parameter adjustments (tags) by the artist during execution of process based on system's outputs	Multiple static works printed on paper; flat system

Fig. 32 Dorin et al.'s table of generative works explored using their framework. Adapted from DORIN ET AL., 2012

3. EXAMPLES OF GENERATIVE ART



CERTIFICATE

This is to certify that the Sol LeWitt wall drawing number 366 evidenced by this certificate is authentic.

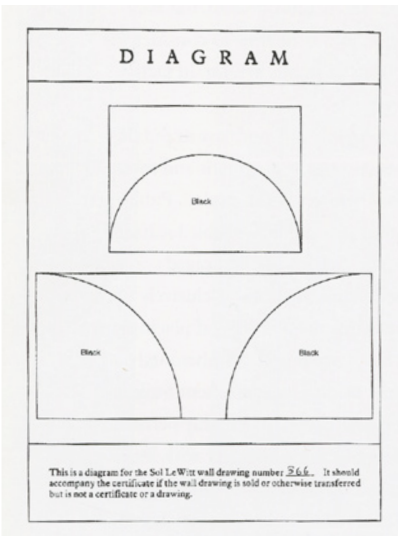
Black arcs using the height of the wall as a radius, and black arcs using the midpoints of the wall as a radius. The arcs are filled in solid and drawn in India ink.

India ink
First Drawn by: Carol Androccio, Biagio Caldarelli, Sol LeWitt
First Installation: Galeria Marilena Bonomo, Bari, Italy.
January, 1982

This certification is the signature for the wall drawing and must accompany the wall drawing if it is sold or otherwise transferred.

Certified by Sol LeWitt
Sol LeWitt

© Copyright Sol LeWitt Date



DIAGRAM

Black

Black Black

This is a diagram for the Sol LeWitt wall drawing number 366. It should accompany the certificate if the wall drawing is sold or otherwise transferred but is not a certificate or a drawing.

Fig. 33–34 Certificate and diagram for *Wall Drawing #366*. Sol LeWitt, 1982. LEWITT, 2000 : 90

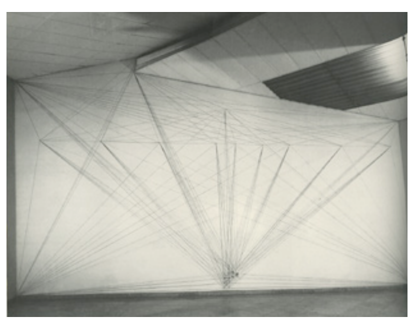


Fig. 35 *Wall Drawing #51*. Sol LeWitt, 1970. All architectural points connected by straight lines. LEWITT, 2000 : 172

GALANTER BOLDLY STATES "generative art is as old as art itself" (Galanter, 2003 : 1). While the use of the term generative art and its definition is relatively new, artists have been using rules as method for automation in their processes for centuries. For example, mathematical and geometric rules used for artistic tiling patterns, like those found in Islamic art of the 9th–13th century, are highly ordered generative systems. (Galanter, 2003 : 12; Dorin et al., 2012 : 240) Since generative art is not recognisable by a distinct style, materiality or technology, and does not pertain to a specific time or ideology in art history, identifying it as such can be difficult. To tell if an artwork is made by a generative system, it is not sufficient to look at the outcome, it is necessary to look at how it was made and to understand its process.

In this chapter I will look at examples of generative works spanning from the 20th to the 21st century, although it is by no means a complete, nor chronological account of generative art. The aim is to show the many faces of visual generative art through a selection of works that use a wide range of different systems, technologies and levels of complexity. The works are ordered into three main technology groups, based on their systems: analogue, mechanical and digital.

3.1. ANALOGUE SYSTEMS

There are many examples of generative art to be found within the conceptual art movement of the 1960s. While conceptual art is not synonymous to generative art, there are similarities and many conceptual artists worked with systems that are generative. Sol LeWitt famously wrote in his *Paragraphs on Conceptual Art* (1967):

> In conceptual art the idea or concept is the most important aspect of the work. When an artist uses a conceptual form of art, it means that all of the planning and decisions are made beforehand and the execution is a perfunctory affair. The idea becomes a machine that makes the art.

The focus lies, like in generative art, in designing the process. The "machine that makes the art" is LeWitt's version of an autonomous system. His wall drawings were one of the earliest inspirations for my project and ideal examples of highly ordered, combinatorial analogue generative systems. His systems consist of written instructions to be interpreted and executed by others, which makes them particularly interesting in relation to my project. The instructions vary from step-by-step lists to

Fig. 36 *Wall Drawing #797*. black, red, yellow, blue marker. Sol LeWitt, 1995. The first drafter has a black marker and makes an irregular horizontal line near the top of the wall. Then the second drafter tries to copy it (without touching it) using a red marker. The third drafter does the same, using a yellow marker. The fourth drafter does the same using a blue marker. Then the second drafter followed by the third and fourth copies the last line drawn until the bottom of the wall is reached. GROSS, 2012 : 21

descriptive sentences of different lengths and complexities, sometimes accompanied by diagrams to further clarify the text. Since the works were for the most part meant to be mobile, continuously re-drawn and painted over on-site for every exhibition, the rules and diagrams were also the only part of the work that could be authenticated and sold as certificates (Fig.33–34). The rules allowed for interpretation by the drafts people and the drawings adapted to different scales and sites, which made every iteration of the work different and unique. For example, *Wall Drawing #51* (Fig.35) is a strongly site-specific work for which the directions read: "All architectural points connected by straight lines" (LeWitt et al., 2000 : 43). While *Wall Drawing #797* rely more on the execution of the draftsperson (Fig.36).

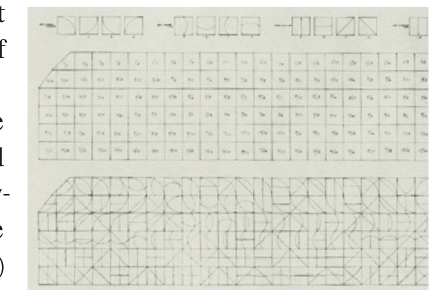


Fig. 37 *Plan for a Wall Drawing*. Ink and pencil on paper. Sol LeWitt, 1975 (detail). LEWITT, 2000 : 192

LeWitt compared his work to that of a music composer, where the interpretation and execution of a score depends on the musician and can vary accordingly. He considered the concept and the finished drawing to be equally important: "The explicit plan should accompany the finished wall drawing. They are of equal importance" (LeWitt, 1971 : n.p.) This separation of the artist from the physical making of the piece meant that the works did not rely on the artist's manual skill. While this was comparable to the role of the architect, who draws the plans for a building but is not involved in its construction, it was unprecedented in the context of visual arts. (LeWitt et al., 2000 : 92–95) Many of his works, including drawings on paper and sculptures, rely on clear combinatorial systems, built on the exhaustive combinations of a given amount of elements. For example Fig.37 shows a plan for a wall drawing with systematic combinatorial pairings of 20 basic elements ordered into a grid: element 1 and 2, 1 and 3, 1 and 4, and so on. Fig.38 shows *Wall Drawing #146*, which is built with a very similar system.

Fig. 38 *Wall Drawing #146*. Blue crayon. Sol LeWitt, 1972. LEWITT, 2000 : 193

Many of LeWitt's contemporaries, conceptual and minimal artists like Eva Hesse, Mel Bochner, Donald Judd, Kenneth Martin and Carl Andre, used geometric order, seriality, sequence and other generative elements in their work. (Galanter, 2003 : 13; LeWitt, 2000 : 41)

Artist Tim Knowles' work perfectly exemplifies disordered analogue generative systems, because he uses natural randomised systems to automate his processes. Knowles is interested in visually recording movement of wind, walking, vehicles, packages in the post, moon reflections on water and others. He records them either through photography or by using self-made contraptions that allow drawing implements to generate marks on paper or canvas. For example, to record the movement of wind in his serial work *Tree Drawings*, he chooses to attach pens to branches of trees, which moved by the wind, draw on carefully placed blank surfaces (Fig.39). Different species of trees create their own signature style drawings depending on their weight, wood flexibility and

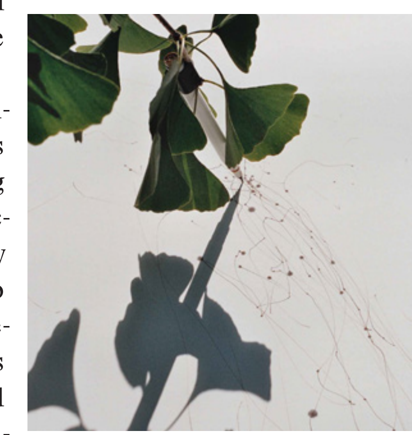


Fig. 39 *Ginko on Easel #1* (detail). Ink on paper and C-type print. Tim Knowles, 2011. DORIN ET AL., 2012 : 252

Fig. 40 *Three Peaks*. Ink on paper x3, C-type print mounted on aluminium. Tim Knowles, 1999. KNOWLES, ND

other physical characteristics. Similarly, in *Balloon Drawings*, he hangs pens on helium filled balloons that move around in the confines of cages put in significant locations, such as the top of mountains (Fig.40). Apart from the drawings as final outputs of the systems, Knowles records and shows the process through photographs and video. (Dorin et al., 2012 : 254; Knowles, nd)

3.2. MECHANICAL SYSTEM

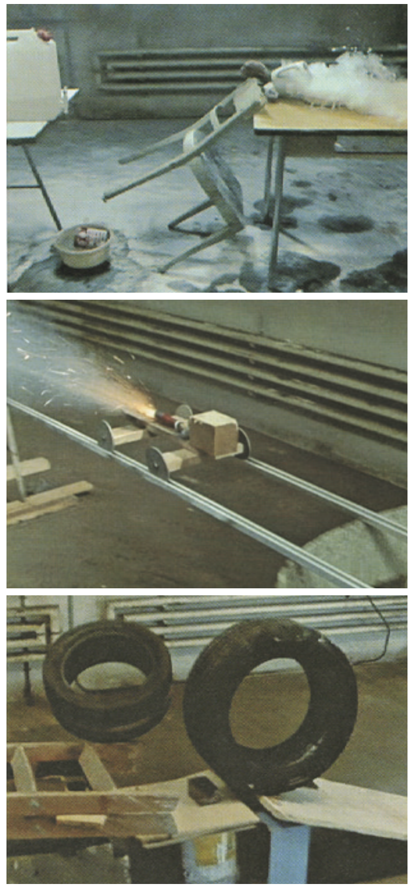


Fig. 41–43 *The Way Things Go*. 16 mm film, 30 mins. Peter Fischli, David Weiss, 1999. FLECK ET AL., 2005 : 98, 99, 102

The famous 30-minute film *The Way Things Go* (1987), by Swiss artist duo Peter Fischli and David Weiss, is a time-based analogue mechanical process which does not produce an output (Fig.41–43). The work *is* the process, like a one-off performance piece. The film documents the system, a chain reaction of everyday objects that could be found lying around in a warehouse or workshop: tyres, buckets, planks, bottles, jugs, garbage bags and chemicals. The objects react in a long chain of cause and effect sustained by their release of kinetic energy. The film is not one long chain, but rather a combination of several smaller chains cut together. The process relies on the very precise placement of the objects and on laws of gravity and chemical reactions. The later released behind the scenes film *Making Things Go* shows the artist rehearsing the complicated reactions and building the sets, a preparation process that lasted over a year. (Frey, 2006) The generative system required many trials, fails and adjustments to perfect it. All the 'environmental interactions' were therefore made before the initialisation of the final work. Once the first reaction was initiated, the system acted on its own. Even though this is not a conventional robot, it is a machine that, once activated, carries out actions autonomously and that features several robot-like contraptions, like small vehicles moving on rails.

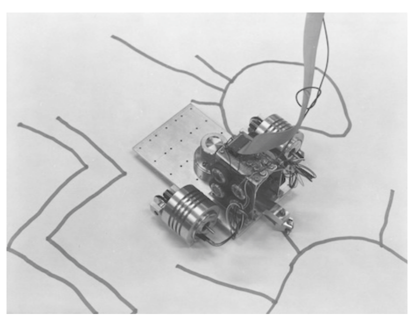


Fig. 44 The 1979 exhibition, *Drawings*, at SFMOMA, featured this "turtle" robot creating drawings in the gallery. GARCIA, 2016

British painter Harold Cohen's life-work *Aaron*, is an artificial intelligence program that can draw and paint. Cohen started working on *Aaron* in 1972 and kept developing it and working with it until his death, in 2016. This example is mechanical-digital, because Cohen built several drawing and painting robots throughout the years that translated *Aaron*'s digital images to the physical world. The earliest version of *Aaron* was quite simple. Cohen defined a small set of rules and shapes inspired by native American art and children's drawings, that the computer composed into abstract black and white line drawings. A robot with a marker would then put them to paper. The robot, called 'turtle', was a small machine that could move around quite freely directly on a paper or canvas. In Cohen's 1979 exhibition *Drawings* at the San Francisco Museum of

Modern Art, the robot was creating drawings in real time (Fig.44). During this initial two decades of *Aaron*'s outputs, the artist would finish the line drawings by hand-colouring them, but as the *Aaron*'s knowledge evolved, so did the robots, which grew bigger and more complex and were ultimately able to mix and paint colours autonomously (Fig.45–46). (Cohen, 2016; Menezes, 2017; Garcia, 2016) His work with *Aaron* helped Cohen understand his own process as a painter better and investigate what are the simplest forms that can make an image evocative.

Fig. 45 Harold Cohen with an installation at the San Diego Museum of Contemporary Art, 2007. COHEN, 2016 : 65

Fig. 46 A close-up of one of Harold Cohen's painting machines. COHEN, 2016 : 65

While Cohen programmed *Aaron* and his robots to paint independently, contemporary Swiss graphic designer Jürg Lehni programs his comparatively primitive machines to translate predefined digital vector drawings into manual drawings. Lehni does not look for perfect results with his "little helpers" but welcomes instead the almost human trembles and wobbles of the strokes, which starkly contrast the clean and precise vector graphic aesthetic they are translating. (Graphic #37, 2016 : 28; Lehni, nd) His first robot, *Hektor*, built in 2002, controls a spray-paint can (Fig.47), and makes permanent drawings on paper or walls, while *Viktor* (2006) (Fig.48) and *Otto* (2014) use chalk to draw and therefore create inherently ephemeral results. *Rita* (2005) can both draw with markers on a white board and erase the drawings with sponges. (Lehni, nd) Her outputs are not permanent either and are meant to be constantly changing. The focus is thereby put entirely on the generative process while it is unfolding, and only documented through photographs and video, like in *The Way Things Go*. In Lehni's project *Empty Words* (2008) a modified vinyl cutter makes typographic posters by cutting small holes into white paper (Fig.49). The project has been presented as an interactive installation in several exhibitions, where the visitors could type their own text into the system and see the resulting poster produced in real time. (Lehni, nd) In this case the outputs are permanent, and the little circles of paper resulting from the holes accumulate on the floor in their own generative installation. Even if some of the systems produce permanent outputs, the interest and focus of the artist is in the drawing processes as they happen, which is why the robots are always shown in action whenever exhibited.

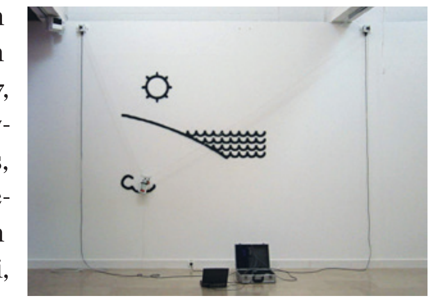


Fig. 47 *Hektor Draws a Landscape*. Jürg Lehni & Alex Rich, 2003. LEHNI, ND

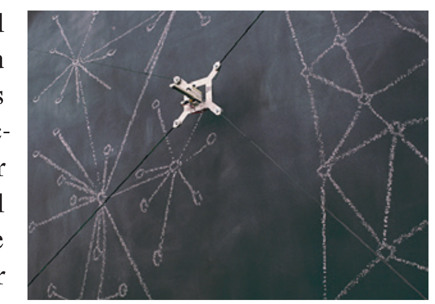


Fig. 48 *Viktor*. Jürg Lehni. LEHNI, ND

There are many other artists employing drawing machines in their work, for example Eno Henze in *Subjektbeschleuniger (subject accelerator)* (2008), Tim Riecke in *con/texture/de/structure* (2006), and Roman Verostko in *Cyberflowers* (2009), (Bohnacker et al., 2012 : 72, 120, 156)

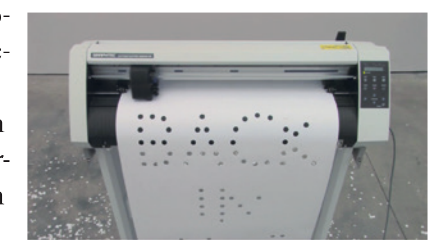


Fig. 49 *Empty Words*. Jürg Lehni & Alex Rich, 2008. Photo: Screenshot from video. LEHNI, ND

Fig. 50 *Nineteen*. Ernest Edmonds, 1968–69. EDMONDS, 2018

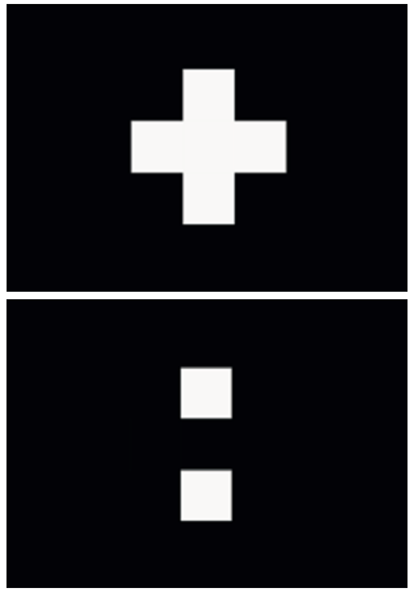


Fig. 51–52 Stills from *Fragment*. Computer-generated video on Umatic tape, 65 minutes. Ernest Edmonds, 1984. EDMONDS, 2018

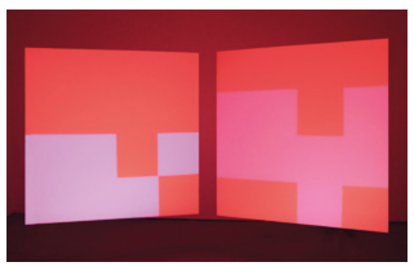


Fig. 53 *Shaping Space*. Installation. Ernest Edmonds, 2012. EDMONDS, 2018

Fig. 54 *Process 18 (B)*. C print, Edition of 8+2 AP, 50cm × 50cm. Casey Reas, 2010. REAS, 2010 : 109

3.3. DIGITAL SYSTEMS

Ernest Edmonds has been working with computational interactive and generative art since the late 1960s and is considered to be a pioneer in the field. He has written extensively about and around the topic of computer programming for making art and has described his own works and motivations on several occasions. For example, Edmonds co-wrote the paper that proposes the generative art taxonomy reviewed in chapter 2.2. Edmonds discovered very early on that computers could be used for solving problems in the context of making art. His first works using programs, including *Nineteen* (1968–69) (Fig.50), were algorithms translated into static physical objects through drawing and painting by hand. (Edmonds, 2018)

A big change in his work occurred in 1980, when he discovered the potential of the computer for making time-based work. His first finished time-based generative art piece *Fragment* (1984), is the recording of the projection of a work that has been generated in real-time (Fig.51–52). The hour-long video shows continuously changing, non-looping compositions of black and white squares and frames. Both the compositions and the timing are controlled by generative rules as they were unfolding. (Edmonds, 2018) In the next phase of his work he started implementing environmental interaction into his systems. While his systems until then had been closed and self-contained, now they were open and reacting to influences coming from outside, like movement. The interaction can either directly cause a visible effect to the system, or a delayed one. Edmonds call the second kind of interaction "influence": the system registers the external stimuli and reacts to it over time. (Edmonds, 2018) Edmonds works always have very few basic elements, like stripes or squares, and focus on simple structures, very careful colour combinations and slow-paced timing. Fig.53 shows the recent work *Shaping Space* (2012), which is an installation with two back projected screens that reacts to the movement of visitors in the exhibition.

American artist Casey Reas is a recurring name in the contemporary generative art community. He is co-founder of the open source programming language *Processing*, which is specifically made for facilitating computer programming for the visual arts. His handbook *Processing. A Programming Handbook for Visual Designers and Artists* (2014), is an excellent tutorial for it. Reas' art explores emergence through software and is visually much more complex than Edmond's. His *Process Compendium* is a collection of works done with *Processing*, based on natural language instructions that allow some space for interpretation by the programmer. (Reas, 2010 : 7, Dorin et al. 2012 : 253) I find this built-in step of human

Fig. 55 *Element 5*. Casey Reas, 2010.
Form 2: Line
Behavior 1: Move in a straight line
Behavior 5: Enter from the opposite edge after moving off the surface
Behavior 6: Orient toward the direction of an Element that is touching
Behavior 7: Deviate from the current direction
REAS, 2010 : 19

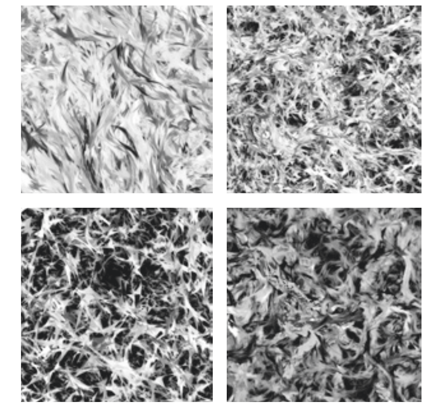


Fig. 56 Images captured from different software interpretations of *Process 18*. Casey Reas, 2010. REAS, 2010 : 110

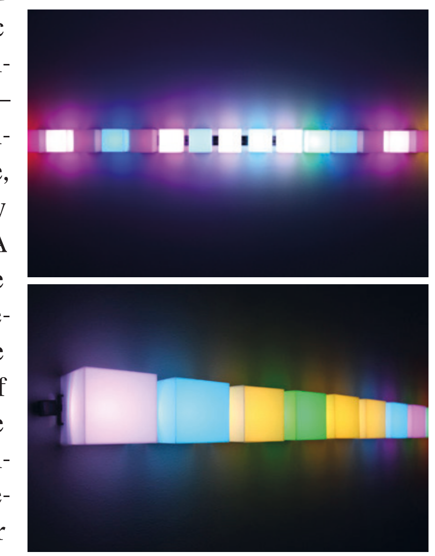


Fig. 57–58 *rgbca #2*. Leds, microcontroller, power supply, acrylic plastic, software, 3"×384"×3.5". Philip Galanter, 2010. GALANTER, ND

interpretation very interesting in the rigid and precise context of computer-coding and it makes a beautiful reference to Sol Lewitt's instructions for his wall drawings. Reas' The description for *Process 18* (Fig.54) is:

> A rectangular surface filled with instances of Element 5, each with a different size and gray value. Draw a quadrilateral connecting the endpoints of each pair of Elements that are touching. Increase the opacity of the quadrilateral while the Elements are touching and decrease while they are not. (Reas, 2010 : 107)

The processes are defined in terms of elements that have a form (line or circle) and one or more behaviours. A representation of Element 5 is shown in Fig.55. The processes are time-based, and once initiated, grow and change potentially to infinity. The outcomes of the works are shown in the form of limited print editions and animation. Fig.56 shows four different interpretations of the instructions for *Process 18*.

Philip Galanter has written extensively about generative art, but he also deals with the topic in his artistic work. His website is a mine of carefully compiled information and references on generative art and artists (Galanter, nd), but it also contains his own portfolio of artistic endeavours, which include many compelling examples of computational generative systems. His time-based installation *rgbca #2* (2010) (Fig.57–58) is an illustration of an elementary, or 1-dimensional cellular automaton, which consists of a single row of cells. Every cell has an initial state, like for example "on" and "off". A change of state in a cell is defined by three factors: its own state and the states of its two neighbouring cells. A set of rules, like a mathematical algorithm, defines the subsequent state of a cell based on the combination of these three states. Galanter represents the cells with square boxes of led lights, and the changes of state are visualised through changes of colour. The piece runs three sets of rules that control the three basic light colours red, green and blue. The cells taken individually are very simple, but as a group they are a complex generative system that can exhibit very diverse and emergent behaviour. (Galanter, nd) In comparison, the artwork *Rule 30* by Kristoffer Myskja, from chapter 2.4., shows the progression of cellular automaton Rule 30 in a two-dimensional grid, which exhibits a distinct pattern. Galanter explores the use of genetic algorithms in several of his works and is interested in showing the generative processes in his exhibitions as they happen in real-time, as opposed to final outcomes.

C. THE SYSTEM

THIS CHAPTER IS a detailed and concise step-by-step rule-guide of the generative system employed for the project. It is not only meant to give an in-depth look at this project, but also to be a tool for other designers to employ for their own work with their chosen material. There is both an analogue and a digital description of the workflow, since both techniques were essential for my work and shaped the visual language of the end-result.

THE SYSTEM

IMAGE 1: B/LI/OB/P/C

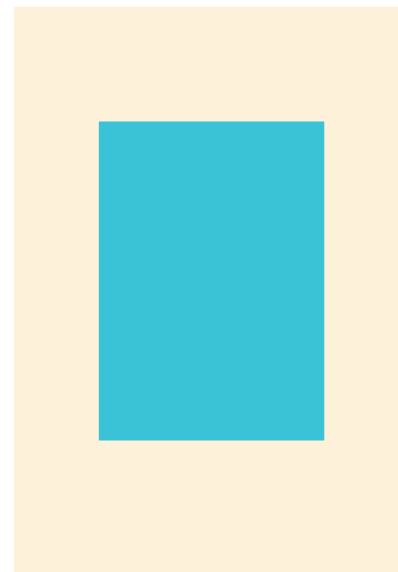


IMAGE 2: S/DE/PA/P/C

S/B = SMALL/BIG
DE/LI = DENSE/LIGHT
OB/PA = OBJECT/PATTERN
P/L = PORTRAIT/LANDSCAPE
C/BW = COLOUR/B&W

MATERIAL SELECTION AND PAIRING CRITERIA

1. Select an x amount of books. IN MY CASE 30.
2. Decide on a sequence of x numbers between 1 and x depending on the average length of your books. IN MY CASE 10 NUMBERS: 1 3 4 6 9 10 15 22 30 39.
3. Scan only the pages from your number sequence. IN MY CASE NOT ALL PAGES WERE AVAILABLE IN EVERY BOOK.
4. Make x groups based on same page numbers. IN MY CASE 10 GROUPS.
5. Decide on 3–5 attributes/tags for your images that are relevant for your subsequent work. IN MY CASE: SMALL/BIG, DENSE/LIGHT, OBJECT/PATTERN, PORTRAIT/LANDSCAPE, COLOUR/BLACK&WHITE.
6. Tag every image with your chosen attributes.
7. Decide on which set of attributes should get paired based on relevance for your subsequent work. IN MY CASE I CHOSE DIFFERENT PAIRING CRITERIA FOR THREE TYPES OF COMPOSITIONS:

Overlappings:	SMALL/BIG	→ OPPOSITE
	DENSE/LIGHT	→ OPPOSITE
	OBJECT/PATTERN	→ ANY
	PORTRAIT/LANDSCAPE	→ SAME
	COLOUR/BLACK&WHITE	→ ANY
Mosaics:	SMALL/BIG	→ ANY
	DENSE/LIGHT	→ SAME
	OBJECT/PATTERN	→ OPPOSITE
	PORTRAIT/LANDSCAPE	→ ANY
	COLOUR/BLACK&WHITE	→ SAME
Shapes:	SMALL/BIG	→ OPPOSITE
	DENSE/LIGHT	→ OPPOSITE
	OBJECT/PATTERN	→ OPPOSITE
	PORTRAIT/LANDSCAPE	→ ANY
	COLOUR/BLACK&WHITE	→ ANY

8. Make groups of images with matching tags and pair them with their counterparts based on the active criteria. IN MY CASE, FOR *overlappings* ALL IMAGES TAGGED B/LI/P GOT PAIRED WITH ALL THEIR COUNTERPARTS TAGGED S/DE/P. FOR THIS COMPOSITION THE TAGS OB/PA AND C/B&W ARE NOT ACTIVE.
9. Try out all the possible pairings in your chosen composition. YOU CAN FIND MY SYSTEMS FOR COMPOSITIONS IN THE NEXT CHAPTER.

Analog option: If you want to work with the analog options suggested in the following chapter *Compositions*, you can avoid the scanning and make photocopies instead.

COMPOSITIONS

OVERLAPPINGS

Digital option: Overlap the two images by centring them on a blank page in their original sizes. Convert one of the images into a bitmap and place it on top of the other to achieve the superimposed effect that allows for both images to be visible. Choose a colour for the bitmap taken from the original image.

Analog option: Print out the images you want to work with in their original sizes or reduce/enlarge them proportionally to each other. Make a photocopy of your first image using the one-colour option on your copier. Put the paper back in the tray and copy your second image on top of it using another colour from the one-colour option on your copier.

MOSAICS

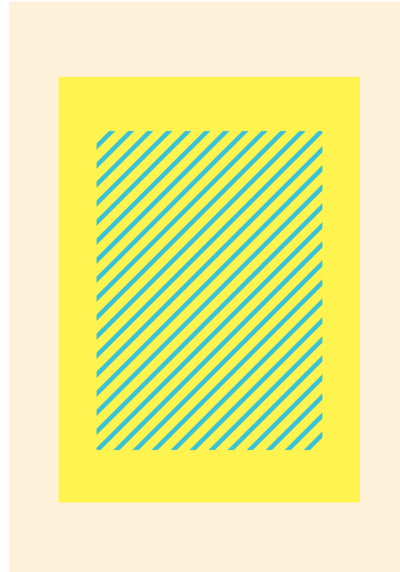
Digital option: Divide a blank page in two by drawing two frames. The frames might both be squares, rectangles, half circles or have organic shapes, as long as they touch seamlessly on one side. Fill the two frames with one image each. Enlarge the images to 300% and centre them in their respective frames.

Analog option: Print out the images you want to work with in their original sizes or enlarge them proportionally to each other. Cut out a small rectangle or half circle from a white sheet of paper and place it on the centre of each image to trace it. Cut out the traced shapes from the two images and tape them together seamlessly. Make a photocopy of your new image using the enlargement option on your copier. (With the 300% option an image of 5×5cm will turn out 15×15cm).

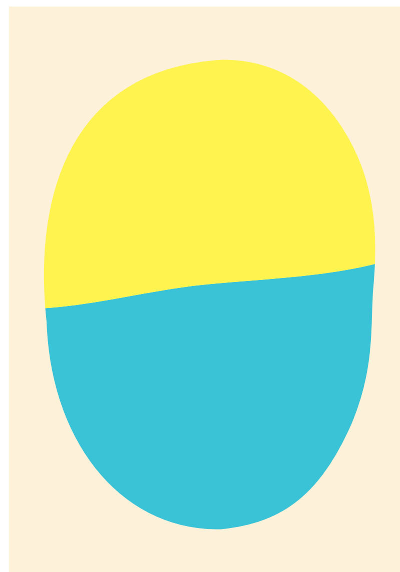
SHAPES

Digital option: Draw a grid of 2×4 on two blank pages and draw a set of 2–4 shapes inside of each grid. Your first shape could occupy 1, 2, 3 or 4 grid spaces, and so on. The shapes should fill about 3/4 of the page. One of the sets should be made of 3 shapes.

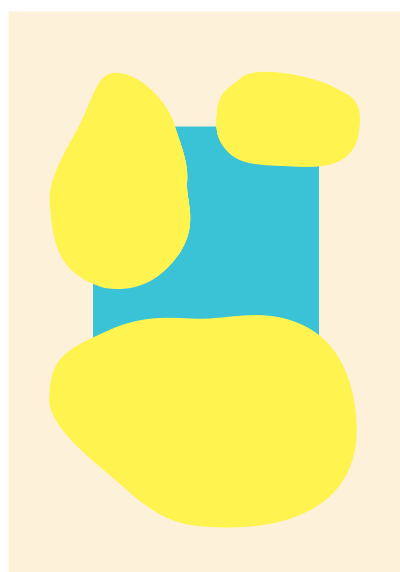
When your shapes are ready combine each set into a compound shape with your pathfinder tool, but keep also an uncombined version on the side. Reduce one of the shapes to 71% of its size, keep the other one as is. Fill the large shape (1) with the larger image (1) of your chosen pair and the small shape (2) with the smaller image (2).



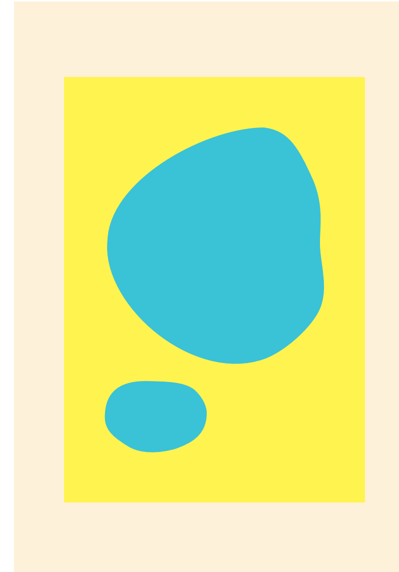
OVERLAPPING



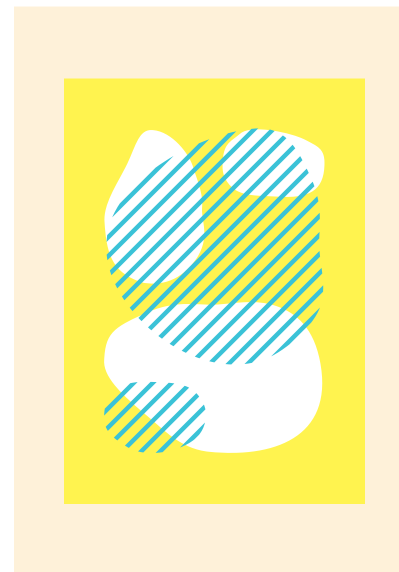
MOSAIC



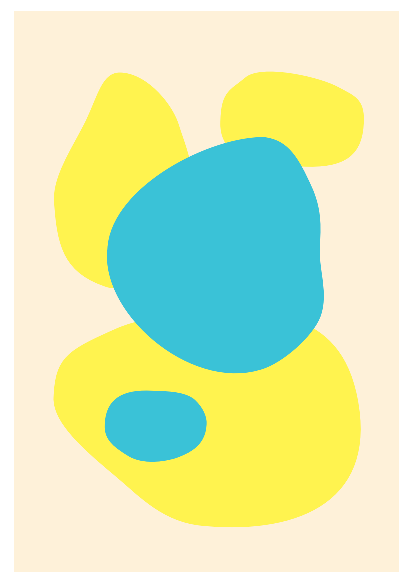
SHAPE: A



SHAPE: B



SHAPE: C



SHAPE: D

Both images should stay at 100% except if they don't fill the shape, in which case they should be enlarged to 300%. Have the two original images at 100% and the two shapes ready for making the compositions:

A. WHOLE IMAGE 2 + SHAPE 1, CENTRED.
B. WHOLE IMAGE 1 + SHAPE 2, CENTRED.
C. WHOLE IMAGE 1 + SHAPE 2 CONVERTED INTO BITMAP, CENTRED.
D. SHAPE 1 + SHAPE 2, BOTH CENTRED.
E. SHAPE 1 + SHAPE 2 CONVERTED INTO BITMAP, BOTH CENTRED.
F. SHAPE 1 REDUCED TO 71%, IN UPPER LEFT CORNER + SHAPE 2, IN LOWER RIGHT CORNER.
G. SHAPE 1 REDUCED TO 71% + SHAPE 2 CONVERTED INTO BITMAP, BOTH CENTRED.
H. Choose a third picture from the same pairing group of your previous two images, which means it either has the same tags as your first or your second picture. TAKE THE UNCOMBINED SHAPE THAT HAS 3 ELEMENTS. PLACE AN IMAGE IN EACH OF THE 3 ELEMENTS, KEEPING THEIR SIZES AT 100%.

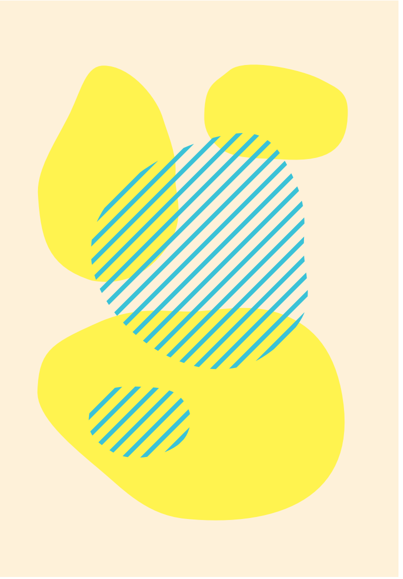
Analog option: Print out the images you want to work with in their original sizes or enlarge them proportionally to each other. Take two blank sheets of A4 paper and fold them into a 2×4 grid (fold the paper in half 3 times). Draw you shapes with a pencil as instructed in the digital option of this exercise. Make two masks out of your paper sheets by cutting out the different elements of your shapes. Make a photocopy of your first masked image. Put the paper back in the tray and copy your second masked image on top of it.

Use the enlargement option on your copier (141%) to make compositions B, D and E. Use the one-colour option on your copier to make the second layer for compositions C, E and G. For composition H you will first have to make three masks with only one element/hole each.

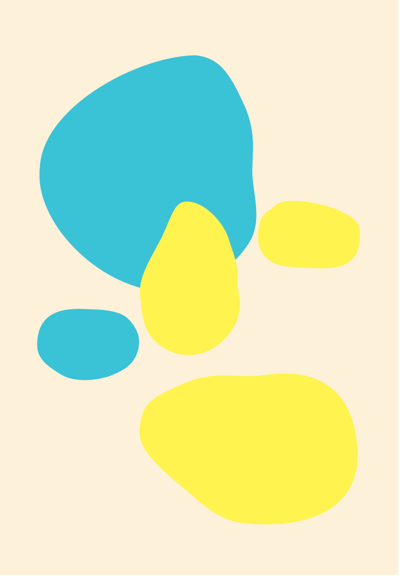
THIRD LAYER

Digital option: The third image chosen from the same pairing group of your previous two images is also the base for making the third layer of your composition. The third layer can be placed on any or all compositions you make from overlappings, mosaics and shapes. Use the image as a background to draw on. Pick your preferred drawing tool and trace shapes from the image. The shapes can be accurate or simplified, they can be a more complete or only a partial translation of the image. You can choose to keep the third layer in its original size or enlarge it to fill your page.

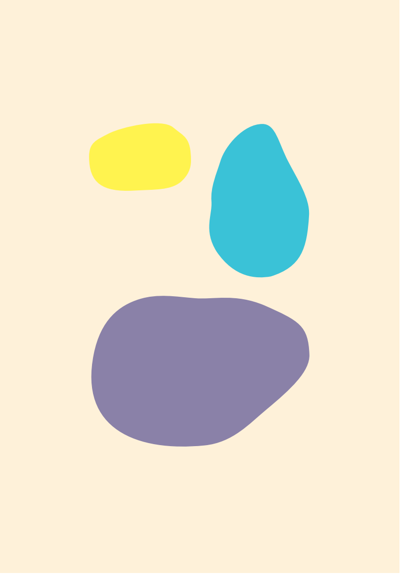
Analog option: Print out the image you want to work with and trace shapes from the image by drawing on it with a black permanent marker. When it's ready turn your sheet over where only your black pattern will be visible. If needed retrace the pattern on this side of the paper to achieve a more even colour. Photocopy your pattern on top of your previously made compositions with the one-colour option on your copier. Select the mirroring option if you wish your pattern to have the same direction of the original image.



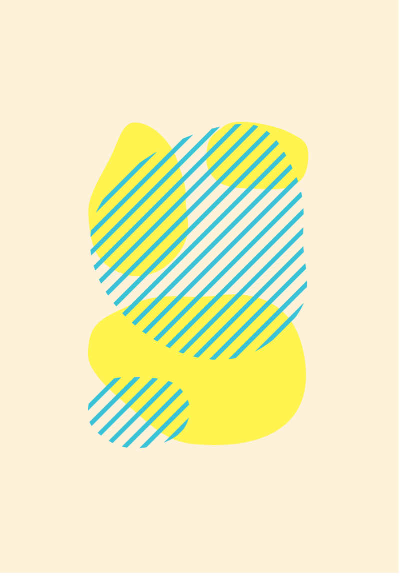
SHAPE: E



SHAPE: F



SHAPE: H



SHAPE: G

4. GENERATIVE SYSTEMS AND GRAPHIC DESIGN

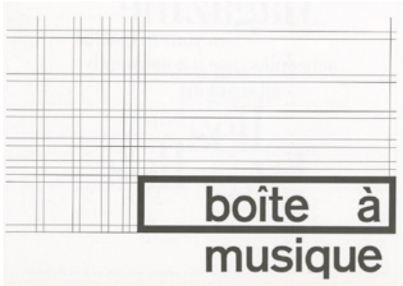
HAVING APPROACHED GENERATIVE systems from the point of view of art and image making, it took me a while to make the connection to graphic design and to understand why this kind of approach made me feel at home and fit my way of working so well. Graphic designers are familiar with using generative systems for their work without necessarily recognising them as such. In fact, everyday graphic design work is permeated with logical and systematic thinking. For example, a layout grid for a book is essentially a generative system: it is designed in advance and clearly dictates the subsequent process of placing contents, which then becomes almost automated. Also, paragraph and character text styles that dictate consistent styles for different parts of a text, such as titles, body text or navigation, function as generative systems. Consequently, a template can be seen as a combination of systems weaved together that, if well prepared, becomes an automated system that enables the conception and execution of a project to be done by different people. The use of systems in graphic design is deeply rooted in the profession and vastly precedes the use of computers.

4.1. KARL GERSTNER AND *DESIGNING PROGRAMMES*

A pioneer in applying systems to the design process was Swiss graphic designer and artist Karl Gerstner with his theories about programmes. In his book *Designing Programmes*, first published in 1963, Gerstner deals with systematic approaches for solving design problems (Gerstner, 2007). He adapts and applies the scientific *morphological method,* developed by astrophysicist Franz Zwicky, to creative design. Gerstner describes Zwicky's method as follows:

> It consists in itemizing all essential elements of a problem … and putting them into a logical order. … These are systematically linked and, with a minimum of time and effort, brought together to produce the optimal solutions to the given problem, including those which would not have been found by following the rigid path of conventional thinking (Gerstner, 2007 : 8).

Gerstner addresses two benefits to applying the method beyond the finding of a solution to the problem. One is the efficiency and economy of the method and the other is its capability to find solutions outside of the proverbial *box*. In other words, the method will not only find a good



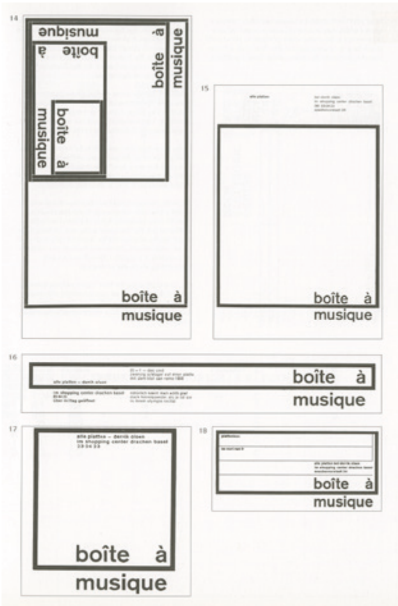
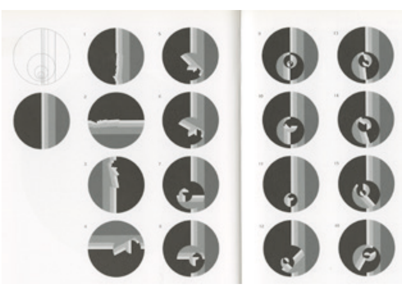


Fig. 59–60 Logo system for *Boîte à Musique*. Logo structure, New Year's card, note paper, advertisements, gift voucher. Karl Gerstner. GERSTNER, 2007: 64–65



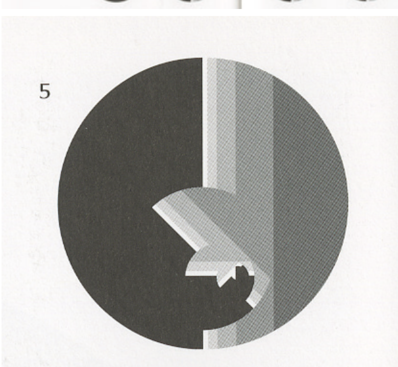


Fig. 63–64 *The Tangential Eccentric*. Schemes of the basic position and 16 regular constellations (detail of number 5). Karl Gerstner, 1956–57. GERSTNER, 2007: 80–81

solution to the problem, it will do it quickly and efficiently and the solution will be unconventional and therefore unexpected.

Gerstner exemplifies the method by applying it to the process of creating a text-based logo. He compiles "the morphological box of the typogram", a table that contains the initial elements and criteria, such as typeface, colour and size, which can then be combined into innumerable variations. He explains: "[the box] contains thousands of solutions which ... are arrived at by the blind concatenation of components. It is a kind of automatic designing" (Gerstner, 2007: 12). Even though the terminology is different, we can recognise the similarities between programmes and generative systems: both have at their base an algorithm, be it analogue or digital, that combines elements into all possible combinations based on given parameters, with some level of automation.

In his book, Gerstner illustrates that programmes can be found and used in very different areas, such as music, architecture and literature, but his focus is on typography, grids and making pictures. The corporate identity project for a record shop in Basel "Boite à Musique" (translates to: music box) is a simple and compelling example for the application of a grid as programme. Fig.59 shows the logo in its default state and placement on the grid, in the lower right corner. The black frame adapts to different applications and print formats by increasing upwards or to the left. The enlargement follows the grid units and always aims to fill the given format: letter paper, advertisements and a gift voucher (Fig.60). (Gerstner, 2007: 64–65)

Around the same time, Swiss graphic designer Armin Hofmann published his well-known book *Graphic Design Manual* (1965), which deals with the fundamental elements of graphic form: point, line and shape. Like Gerstner, he uses a methodical approach to graphic design problems, and while his focus is on abstraction and economic use of fonts and colour, there are several instances where he employs the use of systems. One example proposes a simple grid system for generating shapes that consists of 16 identical circles placed in a 4 by 4 grid (Fig.61). (Hofmann, 1965: 70) A perfect example of a simple generative system.

In 2013, together with Ludovic Balland, I applied a combination of Gerstner's format-adaptive grid and Hofmann's shape generator for the identity of an art exhibition in Basel, the *Swiss Art Awards*. We appropriated Hoffman's system as a tool for making our own shapes and adapted the circle grid to different formats (Fig.62).

Gerstner also applies his programmatic thinking to making pictures. In his work *tangential eccentric* (Fig.63–64) he builds a movable system that in its default position is unfinished and that the onlooker is invited to change into different constellations: "if he [the onlooker] follows

the rules he finds not merely one but x possible completions of the picture" (Gerstner, 2007: 78). He explains the structure and intention of the system as follows:

> Five circles, the smaller always within the larger one, are arranged eccentrically on the same axis. Parallel straight-lines are at a tangent to them. Each parallel forms part of a continuous grey sequence from white, the smallest, to black, the largest. The circles are movable. The movement interrupts the units of the grey sequence and brings them in each revolving phase into a new aleatory or regular constellation. The regular ones can be obtained by a revolution to left as well as right, with different results, see 7+8 (Gerstner, 2007: 80).

He lists 16 iterations of the system by describing their formulas. For example, constellation 5 is achieved by "Rotation of the circles through 45° respectively to left" (Gerstner, 2007: 80). The interest in movement and interactivity remain a constant is his serial colour squares, where he experiments with simple grid systems of different colour hues that can be manipulated by the onlooker (Fig.65).

The concepts that Gerstner discusses in *Designing Programmes* are still relevant and can be understood as prerequisites for computational systems employed in contemporary graphic design (Gerstner, 2007: 8, Graphic #37: 3). It is easy to imagine the criteria of his *morphological box of the typogram* become parameters in a computer algorithm or his colour squares translated into digital space, where they could continuously move from constellation to constellation. Gerstner was essentially laying the grounds for interactive and adaptive generative systems, but never made the step into the digital world, unlike some of his contemporaries like Ernest Edmonds and Harold Cohen.

Today, adaptive and personalised design solutions have reached a new level of complexity thanks to the possibilities offered by the computer. Designers build their own tools and generative systems to produce unique design solutions.

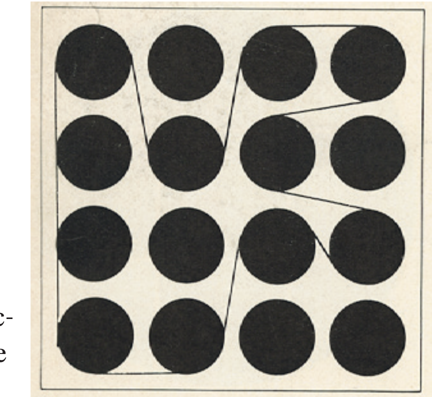


Fig. 61 Starting position: 16 dots. Certain dots are singled out and linked together. Armin Hofmann, 1965. HOFMANN, 1965: 70

Fig. 62 Identity system for *Swiss Art Awards 2013*. Banner 1.5 × 3m, poster F4, advertisement. Siri Bachmann & Ludovic Balland, 2013.

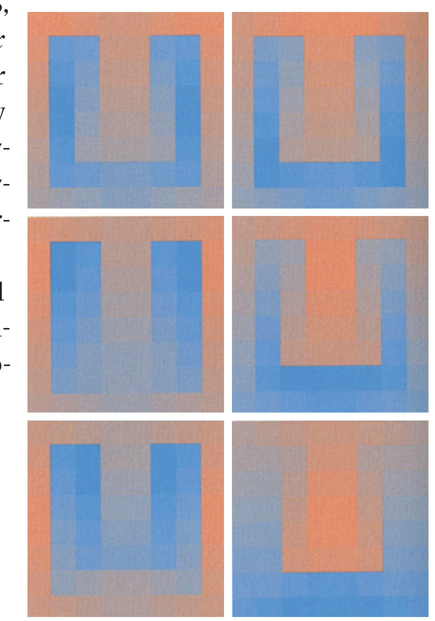


Fig. 65 Variations of *Carro 64*. Karl Gerstner, 1958. GERSTNER, 2007: 112

Fig. 66–68 3 spreads from *Conditional Design Workbook*. Luna Maurer, Edo Paulus, Jonathan Puckey & Roel Wouters, 2013. MAURER, 2013

Fig. 69–70 *Place a Stone*. Detail of the names and finished memorial embedded in the pavement of the Dam Square, Amsterdam. Studio Moniker, 2015–16. Photo: Gert Jan van Rooi. MONIKER, ND

4.2. CONTEMPORARY GENERATIVE GRAPHIC DESIGN

Korea-based graphic design magazine *Graphic* (2016) discusses the topic of computation in graphic design in issue #37: *Introduction to Computation*. The issue revolves around interviews conducted with contemporary design studios that use computation in their practice, discussing the core ideas of the logic, abstraction, rules and systems involved. Editor Kyushu Shim reminds us of the important role tools play in shaping our designs: "Tools contribute greatly to the way designers engage with their form and, often, become the logic and process of design" (Graphic #37:7). He invites designers to think of tools not just as instruments that carry out functions, but as integral parts of the process that continuously inform it and customise it in a looping relation. A "making-in-thinking" approach that requires the designer to understand the tool's parameters and functions and, ideally, to make his own tools (Graphic #37:7). Much like a painter or a woodworker, who has to understand the characteristics of the materials and tools he is working with, a designer should as well. Once he knows them, he can break out of their parameters by experimenting and shaping them to his heart's desire (Graphic #37:54, 118, 184) The Hague based designer Erik van Blokland says on the topic: "By taking control of the tools, the output will be less generic and more personal. The tool can be made to support an idea, rather than having to compromise the idea to fit the tool" (Graphic #37:72). Customising tools and relying on systematic approaches can help the designer feel more connected to the work and the process of creation and avoid making obvious choices (Graphic #37:64, 104).

Even though the magazine focuses on systems and projects made with computer programming and encourages designers to get acquainted with this often daunting language, the concepts are still valid for analogue approaches, as Amsterdam based studio Moniker exemplifies with their *Conditional Design Workbook* (Fig.66–68). Conditional Design is a design method which focuses on the process rather than the finished product. The book brings these ideas into physical reality in a playful and fun way by proposing a series of simple analogue workshops that require paper, coloured pens and the participation and collaboration of several actors. The participants are invited to follow a step-by-step guide of simple written rules that result in unpredictable outcomes. (Graphic #37:62) The participatory aspect of conditional design is fundamental in many of the studio's projects and often involves the public as well. In *Place a Stone*, they invited the public to each (virtually) place a stone to help write the names of victims for a memorial in Amsterdam's Dam Square, by visiting placeastone.nl (Fig.69–70). Over the course of 9

months, each visitor was allowed to place a stone and to move a stone, which led to a continuously changing typographic system. The result was carved in stone and permanently embedded in the square. Moniker's Luna Maurer has worked on many analogue generative projects, which can be admired on the website of her previous studio (Maurer, nd). Her work is often based on simple written rules reminiscent of Sol LeWitt's instructions for his wall drawings, except that in Maurer's case they are executed by participants from the public in a communal effort, rather than skilled craftsmen. Several of these projects are made in the context of exhibitions, where visitors are given pieces of tape to add to images and patterns on floors or walls and slowly grow in a participatory effort. In her project *Human Interference*, which is still open for participation, visitors are invited to send in hand-made drawings based on a list of instructions (Fig.71–72). (Maurer, nd)

The fact that designers are making their own tools customised for specific projects, combined with the core characteristic of generative systems of producing multiple, sometimes infinite outcomes, has made design infinitely bespoke. For example, design studio Catalogtree made a visual identity project for NEXT architects, where instead of delivering one perfectly shaped logo, produced thousands of variations for it: 87,000 to be exact, "one for every hour in the next 10 years" (Graphic #37:104). Similarly, but with an added layer of interactivity, Sagmeister & Walsh designed the identity for Casa da Música (Fig.73). They built a logo generator which allows a 3D-model of the logo to appropriate the 17 dominant colours of any uploaded image, like a chameleon. This allows for an infinite amount of variations that keep the identity new and makes it highly adaptable to any needed purpose. (Sagmeister & Walsh) An example outside of logo design is SEA Design and Field's project *10,000 Digital Paintings* for paper merchant GF Smith, where they created a unique folder for every bundle of promotional paper samples they would send out to clients (Fig.74) (Graphic #37:118). Similarly, MuirMcNeil produced 8,000 unique covers for *Eye 94* (MuirMcNeil, nd). Even multinational mega-brand Ferrero employed algorithms to generate seven million one-of-a-kind packaging designs for Nutella. In these projects it seems like the notion of finished, final products is fading and being replaced by endless variations and iterations of it. This tendency speaks to the fluidity, mobility and fast pace of current times.

The process-focused approach of generative design systems has promoted sharing and dialogue between designers and the public. Designers want to talk about and show the processes and tools that were used or made for their projects. These contributions feed into a continuously looping and growing network that is beneficial to everyone. Some projects are specifically made for sharing, like *Conditional Design*

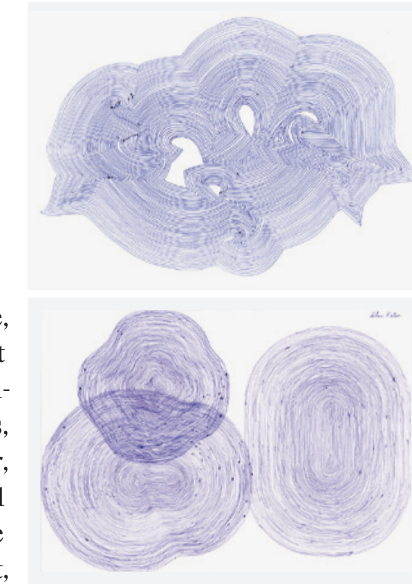


Fig. 71–72 2 drawings from *Human Interference Project*. Luna Maurer, 2011.
1. Use a white A4 sheet and a ball pen.
2. Draw a closed shape on the paper.
3. Repeat the shape to its interior until there is no space left in its center(s). Repeat it to its exterior until it touches one side of the paper. Choose the distance so that you can make approx. 50 iterations on the paper.
4. Try to repeat each iteration in the exact same way. MAURER, ND

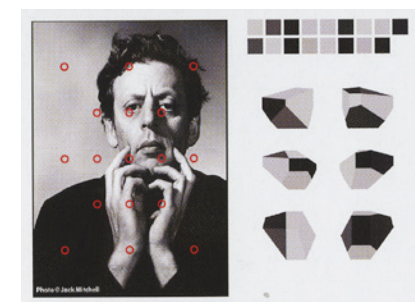


Fig. 73 Corporate design for *Casa da Música*. Sagmeister & Walsh, 2007. BOHNACKER, 2012:129

Fig. 74 *10,000 Digital Paintings*. SEA Design and Field's, 2011. BOHNACKER, 2012:32

Workbook, which not only is a tool by itself, but encourages readers to use as a guide to create their own workshops. German computational designer Benedikt Gross, co-author of the book *Generative Design* (Bohnacker et al., 2012), likes to share his knowledge and tools as well. He not only wants to "give something back to the internet", but is interested in seeing how other people apply his ideas and tools in their work, and draws inspiration from it for his next projects. One of his open-source tools is *Basil.js*, a javascript library for InDesign. (Graphic #37:54). The thriving dynamic of sharing is exemplified in the collaboration between Jürg Lehni and Jonathan Puckey. After Jürg made and shared his Adobe Illustrator plug-in tool *Scriptographer* in 2001, which he also used to program his drawing robot *Hektor* (See chapter 3.2.), a dialogue started between him and Jonathan, who was using the tool in a lot of his work. They discussed features, limitations, problems and possible improvements of the tool, which led to a fruitful collaborative project: open-source tool *Peper.js* (Graphic #37:26). These are just a few examples, but there are endless open source tools and codes available online, for example shared on the development platform GitHub.

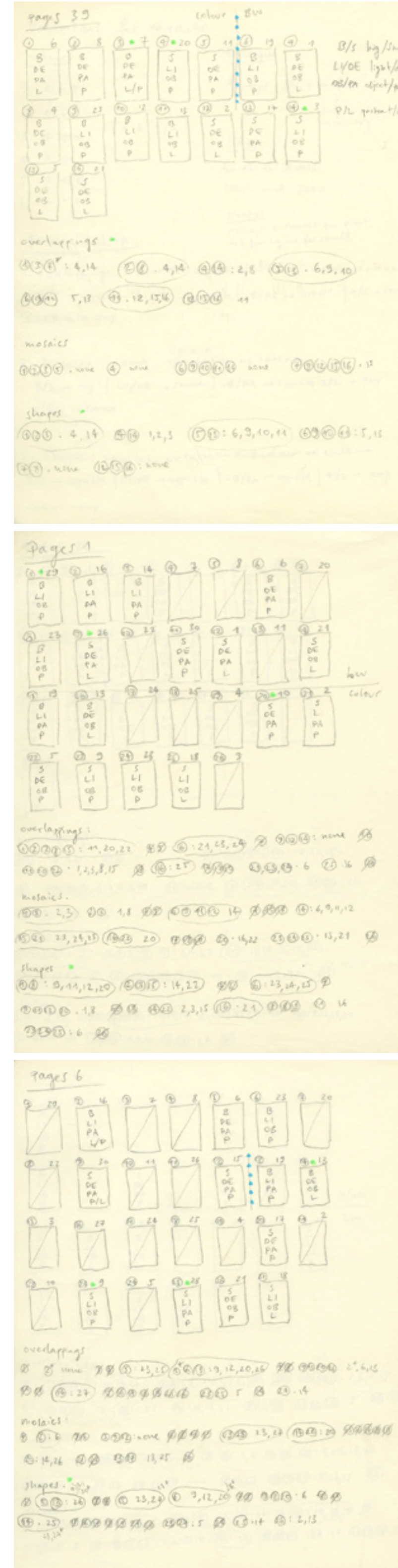


Fig. 75–77 Pages from my notebook showing the taggings and pairings of groups 22, 1 and 6.

D. EXECUTION OF THE SYSTEM

August

D.1 COMPOSITIONS

After the try-out phase, I switched to working primarily with the computer. My generative system was ready to be applied on the entirety of the material, one group of pages at a time. The order in which the 10 groups would get selected for compositions was dictated by the rule of only using each book once, and the fact that not all 10 pages were available in all the books: starting from the group with the least number of pages (group 39 with only 16 pages) and ending with the group containing the most pages (group 9 with 29 pages). By following this order, there would be no risk of "deactivating" books early on in the process that might be needed in the groups with fewer pages and successfully avoid ending up with no "active" books left towards the end.

Because of the generative system clearly dictating every step I should take, this execution phase was mostly automated work. I started out with each group by tagging and pairing all the images into the three different composition types and their custom tagging rules: *overlappings*, *mosaics* and *shapes* (Fig. 75–77). Then I drew the two masks I would use for the *shape* compositions by translating the analogue grid system (See Chapter B.3.3.) I had used in the try-out phase to the computer. After that, I worked through all the variations by following the same order in each group: first the variations within *overlappings*, then the *mosaics* and finally the variations of *shapes*.

For the *overlappings* and *shapes* compositions I would convert some of the images into bitmaps to achieve the see-through overlapping effect I wanted. I coloured these bitmap layers with hues picked with the pipette directly from the original images and saved into my digital colour-palette. I would usually extract 4–6 colours per image and interchange between them in different compositions, depending on which images they were paired with.

After working through the compositions of each group, I selected the three pages/books that would be in the final print before moving on to the next group. For the next group I first deactivated the three selected books before repeating the same steps: tagging and pairing, making masks, composing and selecting the three books for final print. By the end, the last group only had three active books left.

At the end of the execution phase the system had produced 1208 compositions and the 10 compositions that would get produced with silkscreen printing had to be selected. While I had reduced the pool from which to choose during the process, by selecting the three pages that would be in the final print of every group, I still had an average of 30 compositions per group that contained the chosen pages. The only editing rule I set for myself was that the 10 prints had to each have a different composition layout (The 10 composition layout can be seen in chapter D). The rest was personal preference.

D.2. THIRD LAYERS AND TEXT LAYERS

Once the 10 prints that I would produce with silkscreen were picked, I started drawing the third layer patterns. I decided on drawing them first by hand, following the same system I had devised during the try-out phase (See chapter B.3.4.). This method felt quicker and more intuitive than doing it on the computer. I then proceeded to re-drawing the patterns using Illustrator.

While I had picked colours directly out of the original images to colourise the bitmap layers in my compositions, I decided on doing something different for the third layers. These graphic patterns had the potential of bringing freshness into the archival compositions, not just with their shapes but also through colour. I knew I wanted to achieve a semi-transparent effect with the silkscreen printing that would make the solid shapes of the patterns clearly visible on top of the other layers, while still allowing them to shine through (in InDesign, the effect corresponds to setting the fill colour to 80% opacity).

I tried many colours and found that pure yellow seemed to work with any image, no matter what colours where already there, while adding a fresh, modern feel to the prints. The yellow however became too repetitive if used on all 10 compositions, which is why I interchanged it with pastel grey and pastel blue.

Now that the compositions were complete, I started thinking about adding information into the layout concerning the images. Throughout the process I had kept this idea

of wanting an image caption at the bottom of the compositions that would contain the title of the book and the page/plate number of the images, the latter being three times the same. The main reason for doing this was to offer the viewer a small indication of the underlying system on which the project is built. Another motivation for adding information was to make sure that the prints would have a graphic design element to them that would steer them clear of being art. Which is why I decided to move the text from being a separate footnoted caption to becoming part of the layout by setting them within the compositions.

While the graphic designer in me wanted to go big and make a statement with the typography, I soon realised it would overpower and trivialise the images all the while making poor conceptual sense. The result is small set type blocks each put in the corresponding corners of the image they caption. In which of the four corners was mainly based on readability.

E. PRODUCTION OF FINAL OUTCOMES

September-October

AS PREVIOUSLY MENTIONED, the wish to work with a high-quality analogue printing technique, namely silkscreen printing, strongly influenced the decision to make prints as the end-result of my project. There were two other factors, however, that supported and consolidated the idea. One was knowing from the start that the project was going to be exhibited. This fact made me approach the project differently and think more along the lines of making something that could appropriately fill an exhibition space. The other was the purpose of the project to shine a light on the resources of the VRC: hanging prints on the walls seemed like a good way to achieve that.

While the prints were a clear goal I worked towards throughout the project, I was aware that the generative process was the focus and the heart of it. Generating a large number of outcomes is one of the core aspects of a generative system and showing only a carefully selected 1% of all the compositions would defeat the purpose of the project. Disclosing the sum of all the results the system has produced had to be an essential part of the final product. One idea was to simply print out all the compositions on a stack of A4 paper and collect them in a binder to have as a rough documentation for the exhibition. Another possibility I considered was showing the compositions with a digital slide-show, projected or shown on screen in the exhibition. I dismissed the digital option quite quickly since the effect of it would have been so much weaker. A physical stack of over 1000 pages immediately makes a statement about the project and gives a much quicker overview of the results. The goal is not to look at every single composition, but to leaf through them and experience the mass and variations.

The stack of A4 paper collected in a binder evolved into a full-blown book project. The main reason for this was the wish to include a dissection and clarification of the generative system and overall process of the project and not just to show the outcome. I also wanted the set of written rules that made up the generative system to be available for the visitors of the exhibition to take-away and use for themselves as a tool for working on their own projects. This resulted in a separate 8-page brochure that only contained the text portion of the book.

E.1. PRINTS

The prints were the first to go into production. I started by buying the paper and cutting it into A2 size ready for their first layer of printing: the inkjet layer, which consisted of the full-colour portion of the print and the captions. I had to make enough copies of each print to account for possible mistakes and imperfections during the silkscreen printing process. Differing amounts of silkscreen layers accounted for different quantities of copies: 54 in total. Also, in preparation for the next stage, I had to print the remaining 16 layers on transparent film, which I would later need for exposing on the screens. I was able to do the inkjet printing and the printing of films in the school’s Printlab, with the help of workshop master Markus Ahonen and fine-art printer Jarkko Sopanen.

Next, I moved into the school’s silkscreen studio. Workshop master Pia Parjanen-Aaltonen and silkscreen teacher Jukka Lehtinen helped me getting started and making sure I had everything I needed for succeeding with the project. I worked with two A2 sized screens at a time, which together would fit 4–6 layers at a time. (The coating, exposing and washing of two screens, including the waiting times in-between stages, would usually take half a day to prepare.) After figuring out the most effective use and order of screens and layers, and a general attention to precision and detail throughout the process, the mixing of colours was probably the most important component for the successful outcome of the prints. The digital simulations of the prints I had prepared in InDesign, together with the digital printouts I had on hand, were very helpful when mixing the colours. But getting them just right depends very much on a trial and error system and can ultimately only be properly judged with a test print on the same paper used for the actual prints. Especially if the paper is not high white, the colours can look very different in the pot and on other types of paper. The hardest colours to mix were the light blue, grey and beige of the two masks and third layers. They were essentially 99% white ink and turned very easily too dark when adding the needed colours. While these white-based colours were tricky to mix, they were ideal for achieving the desired opacity of the third layers, without any need for extra tricks. Unfortunately, this was not the case for the bright yellow layers. Pure yellow would essentially disappear if printed on top of other colours and end up looking very different from the rest of the third layers. To solve this problem and reach the same opacity as the rest of the third layers, I had to first print the yellow layers with a coat of white ink and only then print the pure yellow on top.

The entire printing process took about 10 days, scattered over the course of a month, depending on the availability of the silkscreen studio. The production went smoothly and according to plan, without any big surprises or set-backs. Once the prints were ready, I focused on getting the book finished in time for the exhibition.

E.2. BOOK

I started working on the book around the same time I started the production of the prints, during the days that the studio was occupied. A rough idea of the structure and content of the book had formed during the execution phase and boiled down to: the system, the index of the archival material (the books and the pages), an index of the shapes/masks and the patterns/third layers, and 1000 compositions divided into 10 groups. I wanted the book to be a comprehensive reference work of the project process that would guide the reader through it in a clear and transparent way. All the information needed to reconstruct every step of the way would be available and re-enforced by cross-references between the sections.

The first task I set for myself was editing the 1250 compositions down to 1000. I wanted the number to be a nice round 1000 because it would fit well into the narrative of picking 10, but also because I thought going through all the images again to eliminate both mistakes and repetitions would be beneficial overall. The process was long and difficult but eventually I managed to cut out the extra bulk. I made sure not to edit based on preference, i.e. cutting out the compositions that felt the least compelling, but on having a selection of results as equal and diverse as possible.

Then, I proceeded with making the index of material I had used for the project. I translated the group of photos

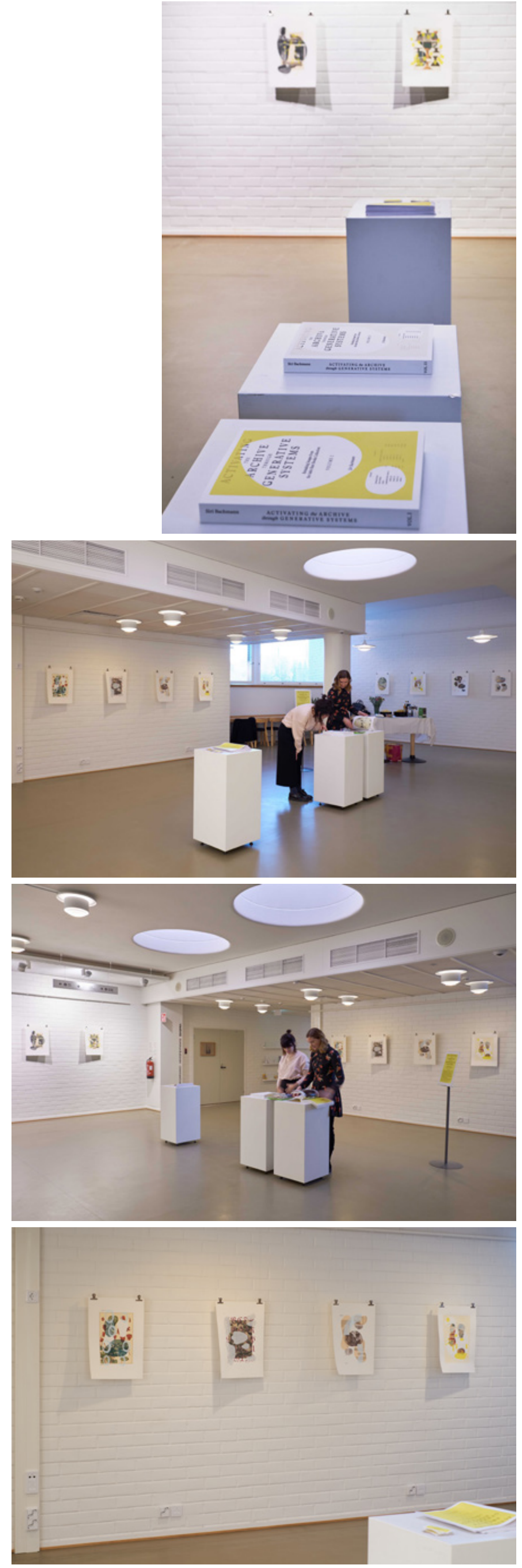


Fig. 78–81 *Activating the Archive through Generative Systems—Remaking Images from the Aalto Rare Books Collection* exhibition at the Harald Herlin Learning Centre, Otaniemi, 2017. Photos: Jon-Erik Räty.

I had made at the beginning of the try-out phase into a similar version for the book and combined them with all the tag information and pairing results from my notebook, including which pages were selected for the final prints. To maintain the correct size ratio of the pages to each other, like I had done throughout the project, I scaled them all down to 10% of their original size.

The idea of printing the third layers on transparent foils came from the decision not to overlay them directly on each composition, since this would have caused a lot of repetition, but also not wanting to only show them separately. By printing them on movable foils, the reader could try the patterns out on any composition if so desired. The foils are attached with photo mounting corner stickers at the beginning of the group they belong to. This way they can be secured or moved at will. Unfortunately, the foils have the wrong grain direction for the book and are not able to bend enough towards the middle sections of the volumes which causes them to snap out of the corners.

The introduction and text describing the system at the beginning of the book are also the contents of the do-it-yourself take-away brochures I printed separately for the exhibition. I had intended to develop the brochure further by adding visuals to support a clearer understanding of the text, but time ran out. I made up for it by adding them here to chapter D.

I printed the book on Munken paper with a digital printer at school, except for the cover which I printed with inkjet in the Printlab, on the same paper as the prints. The glue binding was done professionally. The limits of the glue binding technique were the reason for the book to be divided into two volumes of around 500 pages each.

E.3. EXHIBITION

The exhibition *Activating the Archive through Generative Systems—Remaking Images from the Aalto Rare Books Collection* took place in the Harald Herlin Learning Centre in Otaniemi, from October 23rd to November 15th, 2017. Marika Sarvilahti, who had been my helping hand from the beginning, and Ksenia Kaverina who curates all exhibitions in the LC, helped me with the planning and set-up. The Learning Centre was the ideal place to exhibit the final work because of its direct connection to the original material. The Rare Books Collection is literally stored two floors below the feet of the visitors looking at the exhibition.

I decided to hang the prints as they are, attached only with clips and fishing wire. The main reason for passing on the use of frames was to properly showcase their materiality without the interference of glass. Furthermore, I felt it more appropriate for reflecting their kinship with the books from which they generated. Finally, keeping them looking like a poster rather than a framed piece of art supported my wish to keep the project in the design lane without the risk of swerving too much into the art lane.

The prints were hanging along three walls of the space, surrounding the books which were placed atop two pedestals that allowed the visitors to browse them comfortably while standing. One floor down, a selection of the original books from the Rare Books Collection was exhibited in the glass vitrines of the Visual Resources Centre. A sign informed visitors of the connection between the two parts of the exhibition.

Fig. 82–83 The Rare Books Collection showcased in the VRC as part of the exhibition at the Harald Herlin Learning Centre, Otaniemi, 2017. Photos: Mikko Raskinen.

5. ADVANTAGES AND DRAWBACKS TO A GENERATIVE APPROACH

THE IDEA OF USING a generative process for my project came about quite organically because of the interaction of several influencing factors, the main one being my newly found interest in these kinds of systems and the wish to build one myself. I did not, however, blindly force the idea on to my thesis project, but considered it to be a good match for it. Now that the project is finished, I still find this to be true.

In this chapter I will look at the motivations of artist and designers for choosing generative systems in their work. Even though several of them have already been addressed in other chapters, I wish to compile them with a few additions and compare them to my own experiences and opinions. I will also formulate possible reservations and drawbacks to using generative methods.

5.1. ADVANTAGES

5.1.1. EMERGENCE

One motivation that pushes artists to employ generative systems in their work is the potential for emergence. Emergence occurs when the output of a given system yields something more than the combination of its components. Since the concept of emergence originates in the philosophy of science and there are many definitions of the term, Gordon Monro proposes a definition which is specifically tailored to the discourse of generative art. (Monro, 2009:476) He divides it into two parts:

> 1. The observed behaviour or output of the artwork is unobvious or difficult to predict even when we have complete knowledge of the construction of the system.
> 2. The observed behaviour or output evokes feelings of surprise-wonder-mystery-autonomy, even when we have complete knowledge of the construction of the system. (Monro, 2009:477)

Monro points out that the second clause is necessary because even if an output is difficult to predict it does not necessarily elicit surprise or a sense of wonder and mystery, or a sense of it having "a life of its own" from the observer, which ultimately constitutes the objective of emergent behaviour (Monro, 2009:477).

Generative-art emergence such as described by Monro is difficult to achieve without computation, since it requires a generative system with a certain level of complexity (Link to chapter 2.3.). As defined earlier, the system used in my project is ordered with a low level of complexity that does not exhibit any emergent behaviour. Someone looking at the output of my system will hopefully observe interesting and inspiring images, albeit not unpredictable, and will therefore not experience feelings of "surprise-wonder-mystery-autonomy". The layered compositions are a fairly straightforward and predictable result of the combination of inputs that went into the system.

5.1.2. Unexpected outcomes

If not in the true sense of the definition, I personally experienced some level of emergence while working with the system, in that it produced unexpected results. Or more precisely, results that would not have been generated without the use of a system. This is because relying on a systematic approach that explores many different variations forced me to work with material and combinations of material that I might not have chosen otherwise, therefore producing unexpected results. For example, many of the images I would not have picked for scanning myself but that got picked by the system, turned out to have unforeseen qualities for certain compositions.

The potential for unexpected outcomes is something that I encountered several times as being a motivating factor for artists and designers alike. While Gerstner addresses it from a more work-life perspective with his search for unconventional solutions, others see it as a way of expanding their form-giving repertoire in unpredictable ways (Graphic #37, 2016:126). Painter Harold Cohen was fascinated by the fact that his own rules and parameters could generate things he had never imagined before. (Garcia, 2016)

5.1.3. Efficiency

Employing a systematic approach can also address practical problems like efficiency and economy, as Gerstner already recognised when working with the "morphological method". (Gerstner, 2007:8) These benefits have augmented exponentially with the use of digital computers, especially when working with optimisation problems in the contexts of architecture and design. Italian architect Celestino Soddu, for example, uses genetic algorithms to explore form in correlation with function in his generative software *Argenia*. (Soddu, 2002) But also artists are not indifferent to the practical advantages of generative systems, as Ernest

Edmonds proves when he talks about his wishes to accelerate and tighten the cycle of "making, evaluating and refining" as well as "reducing the enormous decision space of art-making to something manageable" (Boden&Edmonds, 2009:6).

While my choice of an analogue system was not exactly made with efficiency in mind, I did experience the advantage of having a system for reducing and focusing options. It proved to be an effective tool for working with a large quantity of images. Having a system in place for picking the material kept me from getting lost in the amount of visual choices that were available. Without the system I would probably still be deciding which pages to choose from the books.

5.1.4. Tools

In the context of designers building their own generative tools, elaborated in chapter 4.2., the advantages address the designer's work-process as well as the outcome for the client. While the designer can experience a more meaningful, personal connection to his work through a better understanding of the process, the client receives a high level of customisation as well as multiple, sometimes infinite outcomes. By "designing the means of designing", instead of single, finite projects (Graphic #37, 2016:38), there is potential for further development and application in the context of future work. This potential also manifests itself in the growing culture of sharing. This exchange of information between designers and others feeds into a loop that promotes further development.

From the beginning I wanted my system to be a list of instructions. I was inspired by several artists and designers and their recipe-like written rules, such as Sol LeWitt's instructions for his wall drawings, Sonnenzimmer's step-by-step exercises, and the workshops in Moniker's *Conditional Design Workbook*. I thought it could function as a tool for other designers, either to be used as such or as a guide to building other systems.

5.1.5. Freedom

The notion of preventing subjectivity and preconceived notions to interfere in the work is also a motivation for using automated systems. LeWitt wrote that reducing decisions during the process as much as possible, would eliminate the subjective and the arbitrary. (LeWitt, 1967) Gerstner also saw programming as a way of freeing the process from one's own

limitations. It might be counterintuitive that a feeling of freedom in the work process can be generated by the application of constraints (Graphic #37, 2016:64), but I had similar experiences.
For one thing, the system kept me from making premature judgments that might prevent me from trying something because I might think it would not work. But also, by making all the decisions before the execution, I had freed myself from the strains of constant decision-making and second-guessing that usually accompany a creative workflow and could instead concentrate on the experience of the process.

5.2. DRAWBACKS

5.2.1. LACK OF MEANING

In her interview with *Graphic* magazine, Ellen Lupton raises an interesting concern about computational generative design. Or better, a problematic that designers should be aware of and keep in mind when working with digital coding tools: the risk of focusing on purely formal aspects without making a connection to content or culture. This can happen when designers get excited about the possibilities and features of code-generated design and get blinded by the novelty of it. However, after the first reaction of "Oh, wow, it was made by a computer", the lack of meaning makes projects like these uninteresting. Lupton acknowledges that purely formal explorations can be interesting for experiments, but that designers should be careful not to get lost in aesthetics and make sure their projects communicate something. (Graphic #37, 2016: 161–163)

Sol LeWitt included a similar sentiment in his *Paragraphs on Conceptual Art* (1967), when he warned about the physicality of new materials becoming the idea of the work: "Some artists confuse new materials with new ideas. There is nothing worse than seeing art that wallows in gaudy baubles". The cyclicality of "new materials" keeps LeWitt's statement relevant until today.

I think I avoided this problem by using an analogue system for my project, that did not blind me with flashy features nor made me lose myself or the focus of the project in technical questions. I also had the advantage of using materials that were inherently meaningful to the context in which they appeared: they had a cultural connection with the university.

5. Advantages and Drawbacks to a Generative Approach

5.2.2. ANALOGUE TRAPS

While using a generative approach fits my way of thinking and working very well, I still struggled with it at times. Throughout the conception and execution phases of my project, I found that following the rules instead of choosing and doing what I liked was very difficult at times, to the point of being upsetting. These problems, however, would not have arisen had I not worked manually, with an analogue system.

For example, during the first run through of the digitisation process, I childishly boycotted some of the images by simply refusing to scan them and had to go back for them later, causing me to waste time for nothing. This problem was mainly caused by constant comparison with other contents of the books, and not because said images were "bad" or "ugly" per se. On the other hand, when I fell in love with pictures that were on the wrong pages I tricked myself by scanning them anyway to "keep for other purposes".

Later, during the try-out phase, I found myself more than once in the situation of wanting to change tags so that a certain image would end up with another. This was caused by the fact that I had spent time combining images for the silkscreen and mixed-media tests, before all the rules were in place. During this time, I had found combinations I really liked and had a hard time parting with.

6. CONCLUSIONS

THE AIM OF this thesis was to examine how generative systems are used in the context of art and design and to develop a system for working on a project with Aalto University's Visual Resources Centre. Through the theoretical research and practical application of generative systems the thesis also aimed to identify what the advantages and drawbacks are to using systematic approaches in art and design practices.

The research identifies the automated system at the core of a generative process as the defining aspect of generative art. After conception, the artist gives up his control to an external system that executes the process and generates one or more outcomes. Systems can vary greatly in nature, ranging from simple written rules to complex computer algorithms, which result in a wide range of vastly different artworks. Frameworks for the analysis of generative systems help with defining, comparing, and discussing the large scope of generative art.

The research also shows how generative techniques are widely employed in both visual art and graphic design and the analysis of several works that exhibit differing technologies and systems, helps promote a deeper understanding of them. The possible advantages and drawbacks of using generative processes were identified and compiled. The advantages include the potential for unexpected outcomes and emergence, freedom in the work process as well as efficiency and focus. The main disadvantage is the risk of focusing too much on the formal aspects of a work, rather than its content and meaning.

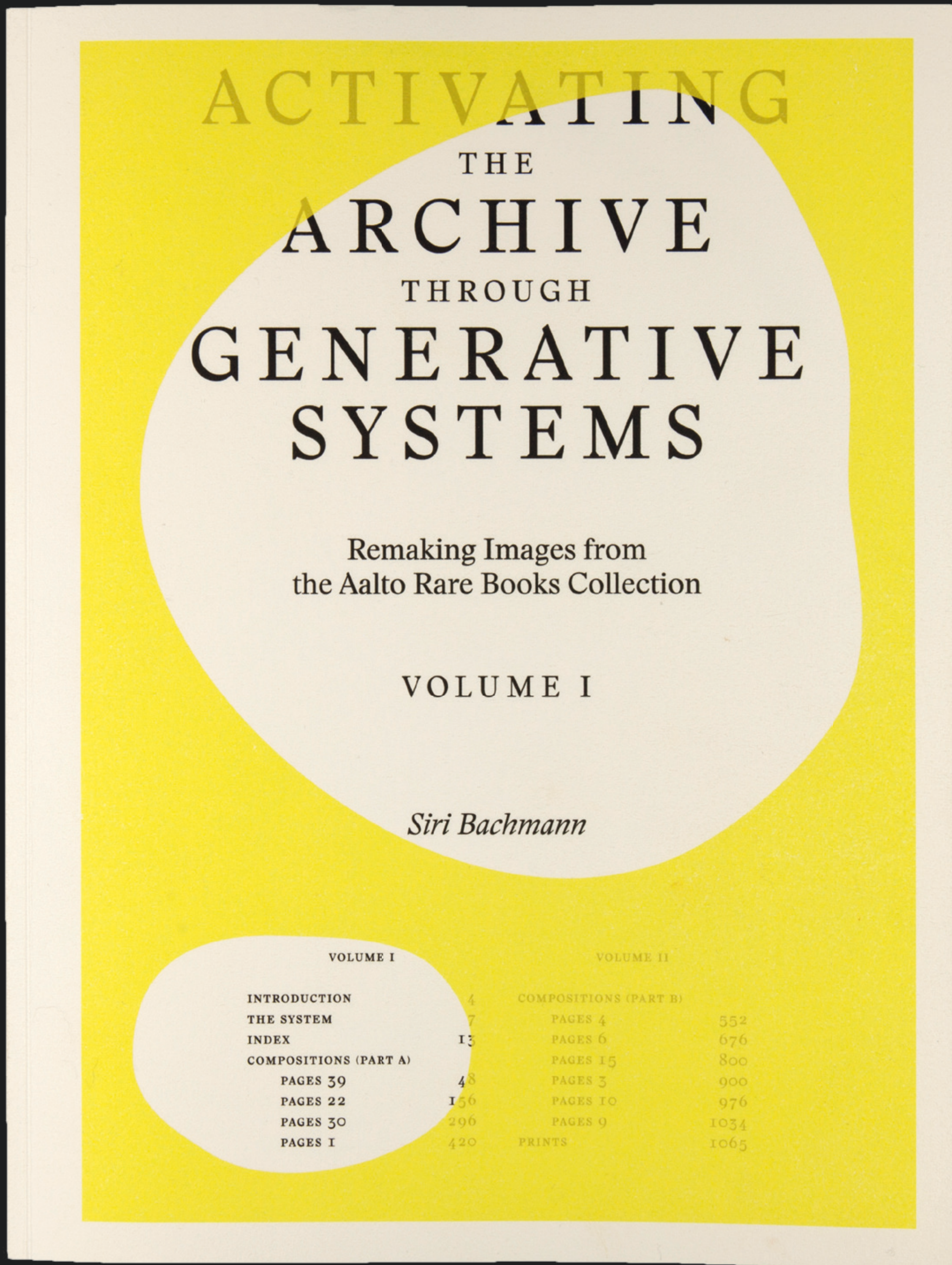
The project resulted in a successful example of an ordered analogue generative system and the outputs, 10 mixed media prints and a book, were exhibited in the Harald Herlin Learning Centre in Otaniemi. Successful for two reasons. One, because the project can be categorised as generative art, since it meets the criteria defined in the literature and can be analysed and described using the frameworks presented in chapter 2. Two, because the exhibition of the project received plenty of positive feedback and generated interest in the resources of the VRC.

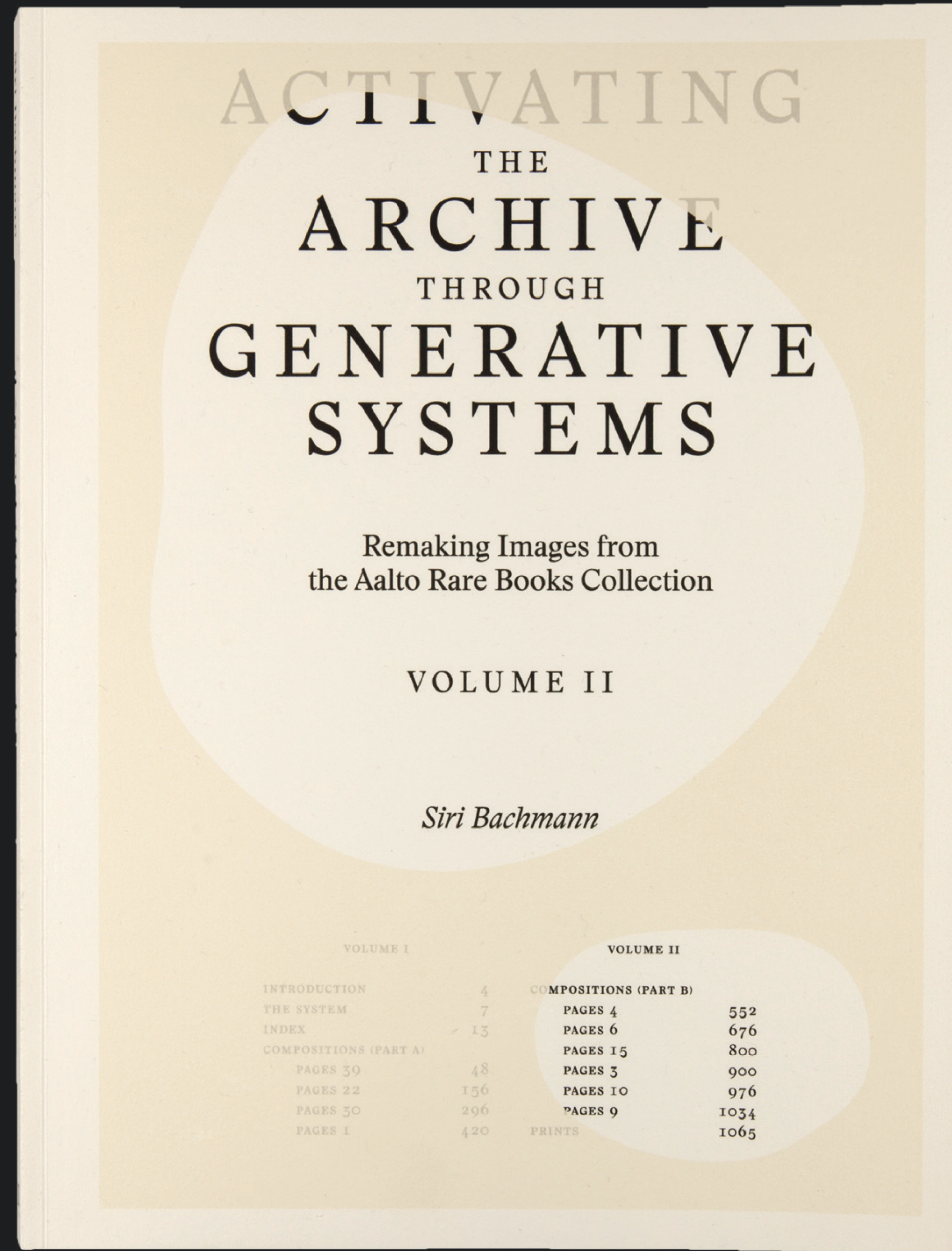
The system devised for the project is also meant to be shared as a tool for fellow designers. Initially, it was intended to be a neat list or paragraph of directions, like those by Sol Lewitt, Sonnenzimmer or Luna Maurer. However, the system resulted in a quite complex and long recipe and could therefore be criticised as being too convoluted for other designers to follow and use for themselves.

Despite the possibly problematic complexity of the tool, it could be interesting to test it in a workshop environment, where participants use the system, or a simplified version of it, for themselves. One possibility could be to test if the system applied with the same conditions and on the same material, but by someone else, would generate similar results. Another could be to utilise the system as a base for developing a custom version for other materials: designers could adapt the rules for selection, tagging, shapes and compositions to fit their own projects.

The project also offers potential for further development through its translation into computer coding. The research made for this thesis motivated me to make the leap into learning more about programming. I took the first step in this direction by participating in a workshop that introduced me to Nodebox, a program for creating generative visualisations designed to simplify programming for graphic design and information design practitioners. The one-week workshop was led by Frederik De Bleser, one of the creators of Nodebox, and gave me an idea of what is doable with the program and which actors are involved beyond it, for retrieving data and publishing interactive visualisations online.

The research and practical work I did for this thesis helped me better understand my work process as a graphic designer and how I can approach the conception of a project systematically to help me get out of my own way and be mindful of possible pitfalls. I very much enjoyed working on the project and am happy I could indulge in the luxury of a slow process that included analogue work with tools I usually do not employ. I am satisfied with the outcome and excited about developing new systems to apply in the context of client work as well as developing my knowledge of computer programming.





Activating the Archive through Generative Systems —Remaking Images from the Aalto Rare Books Collection. Book, 24×32cm, Volume I and II. Siri Bachmann, 2017. Photos: Tove Ørsted.

PAGES

I

VOLUME I

420

COMBINATIONS

Overlappings

1 21 26 : NONE

2 9 28 : 6

5 10 30 : 14 16 19 23 29

13 : 18

Mosaics

1 6 26 30 : 21

2 19 : 9 18 28

5 13 : 10

14 16 : 29 23

Shapes

1 10 26 30 : 23 29

2 : 13

5 21 : 14 16 19

6 : 9 18 28

LEGEND

S/B = Small/Big

DE/LI = Dense/Light

OB/PA = Object/Pattern

P/L = Portrait/ Landscape

C/BW = Colour/B&W

Selected book for previous prints

Page not available

Selected book for final print

Selected book for third layer

1 S-DE-PA-L-C
2 S-LI-PA-P-BW
3
4
5 S-DE-OB-P-BW
6 B-DE-PA-P-C
7
8
9 S-LI-OB-P-BW
10 S-DE-PA-P-BW
11
12
13 B-DE-OB-L-BW
14 B-LI-PA-P-C
15
16 B-LI-PA-P-C
17
18 S-LI-OB-L-BW
19 B-LI-PA-P-BW
20
21 S-DE-OB-L-C
22
23 B-LI-OB-P-C
24
25
26 S-DE-PA-L-C
27
28 S-LI-OB-P-BW
29 B-LI-OB-P-C
30 S-DE-PA-P-C

18

SCALE 1:10

PAGES

4

VOLUME II

552

COMBINATIONS

Overlappings

2 21 : 27

5 15 30 : 14 16 19 23

6 : 9 28

13 : 18

Mosaics

2 5 13 : NONE

6 15 30 : 21

9 18 : 19 27 28

14 16 : 23

Shapes

2 5 21 : 14 16 19 27

6 : 9 18

15 30 : 23

13 : 28

LEGEND

S/B = Small/Big

DE/LI = Dense/Light

OB/PA = Object/Pattern

P/L = Portrait/ Landscape

C/BW = Colour/B&W

Selected book for previous prints

Page not available

Selected book for final print

Selected book for third layer

1
2 S-DE-OB-L-BW
3
4
5 S-DE-OB-P-BW
6 B-DE-PA-P-C
7
8
9 S-LI-OB-P-BW
10
11
12
13 B-DE-OB-L-B
14 B-LI-PA-P-C
15 S-DE-PA-P-C
16 B-LI-PA-P-C
17
18 S-LI-OB-L-BW
19 B-LI-PA-P-BW
20
21 S-DE-OB-L-C
22
23 B-LI-OB-P-C
24
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26
27 B-LI-PA-L-BW
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30 S-DE-PA-P-C

SCALE 1:10

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Fig. 16–17 Rare Books Collection. Aalto University Visual Resources Center, Otaniemi, Finland.

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Fig. 30 Bachmann, S. (2017) Visualisation of Boden & Edmonds' *Generative Art Taxonomy*.

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